# SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE

**(Autonomous)**

**[An Autonomous College Affiliated to Periyar University,Salem,Tamil Nadu]**

**[Accredited by NAAC with 'A' Grade with CGPA of 3.27]**

**[Recognized 2(f) & 12(B) Status under UGC Act of 1956]**

**Katteri – 636 902, Uthangarai (Tk), Krishnagiri (Dt)**

**Tamil Nadu, India**

**Website: www.svmcugi.com Email : svm.maths.pg@gmail.com**

## DEGREE OF MASTER OF SCIENCE IN MATHEMATICS

## CHOICE BASED CREDIT SYSTEM (CBCS)

## REGULATIONS AND SYLLABUS FOR

## M.Sc. MATHEMATICS PROGRAMME

**(SEMESTER PATTERN)**

**(For Students Admitted in the College from the Academic Year 2024-2025 Onwards)**

# REGULATIONS AND SYLLABUS FOR M.Sc. MATHEMATICS PROGRAMME

## (For Students Admitted in the College from the Academic Year 2024-2025 Onwards)

### 1. Vision of the Department

To create teaching and research excellence in mathematics to fulfil the mathematical needs of the society and nation.

### 2. Mission of the Department

To Provide high quality mathematical graduates who are relevant to industry and commerce,mathematical education and research in science and technlogy.

### 3. Definitions

**(i) Programme:** Programme means a course of study leading to the award of the degree in a discipline.

**(ii) Course:** Course refers to the subject offered under the Degree Programme.

### 4. Aims of the Programme

1. To have well–rounded introduction to the main branches of modern Mathematics that keeps an appropriate balance between Theoretical andApplied Mathematics.
2. To have training and knowledge necessary to appreciate and apply Modern Mathematics and to find rewarding careers in Mathematics related fields, or topursue research in Mathematics.
3. To have an understanding of the tools required to be able to quantitatively analyze and understand the natural and social world.
4. To have the ability to solve problems, think analytically, and reason quantitatively.
5. To have the ability to access and communicate Mathematical information.
6. To have an appreciation of the concept of formal Mathematical proof and the ability to write simple proofs.
7. Enable students to prepare for different research/teaching qualification and
8. Competitive examinations, such as CSIR-NET, SET, TRB, TNPSC and UPSC.

## 5. Programme Outcomes (POs)

| | |
|---|---|
| **PO1** | Identify and enhance mathematical and computational strategies in order to solve mathematical problems. |
| **PO2** | Construct logical arguments for solving abstract or applied mathematical problems. |
| **PO3** | Obtain accurate solutions for the community oriented problems via various mathematical models. |
| **PO4** | Know various specialised areas of advanced mathematics and its applications. |
| **PO5** | Present papers in seminars and conferences in order to defend their mathematical skills on various topics in the curriculum. |
| **PO6** | Work as professional mathematicians either in academia or elsewhere. |
| **PO7** | Inculcate knowledge of formulation and apply mathematical concepts which are suitable for real life applications. |
| **PO8** | Crack lectureship and fellowship exams affirmed by UGC like CSIR-NET and SET. |

## 6. Programme Specific Outcomes (PSOs)

| | |
|---|---|
| **PSO1** | Develop the mathematical skills and knowledge for their intrinsic beauty, for proficiency in analytical reasoning, utility in modeling and solving the real world problems by using the concepts of Algebra, Analysis, Dynamics, Differential Equations, Geometry, Topology, Operations Research, Fuzzy Sets & Fuzzy Logic, Fluid Dynamics and Matlab. |
| **PSO2** | Develop computational and logical thinking and the habit of making conclusions based on quantitative information. |
| **PSO3** | Work efficiently and constructively as a part of a team and do project Individually. |
| **PSO4** | Do projects related to emerging Social and Environmental issues. |
| **PSO5** | Join in various Universities and Institutions like IMSC, IISc, etc., in order to do summer research projects on Algebra, Analysis, Topology, Mechanics,Fluid Dynamics, Differential Equations, Number Theory, Matlab, Differential Geometry and Fuzzy sets. |

## 7. Eligibility for Admission

A Candidate who has passed B.Sc. Maths or any other relevant Degree of Periyar University or any other University accepted by the Syndicate of the Periyar University as equivalent thereto, subject to such conditions as may be prescribed therefore are eligible for admission to Master of Science (M.Sc.) Degree Programme in Mathematics and shall be permitted to appear and qualify for the M.Sc. Degree Examination in Mathematics of this Autonomous College affiliated to Periyar University after a course of study of two academic years.

## 8. Duration of the Programme

The Programme for the Degree of Master of Sciecne (M.Sc.) in Mathematics shall consist of two academic years divided into four semesters. Each Semester consists of 90 working days (450 hours).

## 9. Features of Choice Based Credit System

Under Choice Based Credit System (CBCS), a set of Courses consisting of Core Courses, Elective Courses, Skill Based Elective Courses and Extra Disciplinary Course are offered. Beside the Core Courses, which are totally related to the major subjects, the students have the advantage of studying supportive courses and non-major courses. This provides ample opportunity for the students to learn not only the major subjects but also inter disciplinary and application oriented subjects.

## 10. Syllabus

The syllabus of the M.Sc. Mathematics Degree Programme is divided into the following Courses

**(i) Core Courses:** The Core Courses are releated to the Programme concerned including practicals and project offered under the Programme.

**(ii) Elective Courses:** There are Four Elective Courses offered under the Programme related to the major or non-major but are to be selected by the students.

**(iv) Extra Disciplinary Course (EDC):** Chosen by the students from other disciplines /departments of the college.

**(v) Extra Credit Courses:** In order to facilitate the students gaining extra credits, the Extra Credit Courses are offered. According to the guidelines of the UGC, the students are encouraged to avail this option of enriching the knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals, such as SWAYAM, NPTEL, etc.

**11. Programme of Study**

The Programme of study for the Degree shall be in the Branch – Mathematics (Choice Base Credit System) with internal assessment comprised of instructions in the following subjects according to the syllabi and books prescribed from time to time.

**12. Credit**

Weightage given to each course of study is termed as Credit.

**13. Credit System**

The weightage of credits are spread over to four different semesters during the period of study and the cumulative credit point average shall be awarded based on the credits earned by the student. A total of 90 Credits are prescribed for the M.Sc Mathematics Degree Programme which is the minimum Credit requirement for the two year M.Sc Mathematics Degree Programme.

Three domains:

(i) Cognitive Domain

(Lower levels: K1: Remembering ; K2: Understanding ; K3: Applying;

Higher levels: K4: Analysing ; K5: Evaluating; K6: Creating)

(ii) Affective Domain

(iii) Psychomotor Domain

**14. Break-up of Marks and Credits**

The break-up of marks and credits for the M.Sc. Mathematics Degree Programme is as follows

| Course | Number of Courses | Total Marks | Total Credits |
|---|---|---|---|
| Core Courses (Theory/Project) | 12 | 1200 | 57 |
| Elective Courses | 06 | 600 | 18 |
| Common Course | 03 | 300 | 06 |
| Project | 01 | 100 | 07 |
| Internship / Industrial Activity | 01 | 100 | 02 |
| Extension Activity | 01 | 100 | 01 |
| **Grand Total** | **24** | **2400** | **92** |

*The students are advised to complete a **SWAYAM/MOOC** before the completion of the 3rd semester and submit the course completion certificate to the HOD. Extra Two credits will be given to the candidates who have successfully completed.

**15. Examinations**

The examinations consist of Continuous Internal Assessment (CIA) and end of semester examinations (ESE). The ESE shall be of Three Hours duration for each theory courese at the end of every semester. The candidate failing in any course(s) will be permitted to appear for each failed course(s) in the subsequent examination. At the end of fourth semester, the Project Viva-voce will be conducted on the basis of the Dissertation/Project Report of the students by the evaluation of one internal and one external examiner.

To maintain uniformity, particularly for interdepartmental transfer of credits, there shall be a uniform pattern of examination to be adopted by all the teachers offering courses. There shall be three tests, one seminar and one assignment for CIA and ESE during each semester. The distribution of marks for CIA and ESE shall be 25 marks and 75 marks, respectively. Further, the distribution of CIA will be 10 marks for test, 5 marks for seminar 5 marks for assignment and 5 marks for problem solving. The average of the highest two test marks out of the three CIA tests will be taken for CIA.

**16. Components of Continuous Internal Assessment (CIA)**

<table>
<tr><th colspan="2">Components</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td colspan="4">Theory</td></tr>
<tr><td>CIA I</td><td>75</td><td rowspan="2">(75+75 = 150/15)<br>10</td><td rowspan="5">25</td></tr>
<tr><td>CIA II</td><td>75</td></tr>
<tr><td colspan="2">Seminar</td><td>05</td></tr>
<tr><td colspan="2">Assignment</td><td>05</td></tr>
<tr><td colspan="2">Problem Solving</td><td>05</td></tr>
<tr><td colspan="4">Project</td></tr>
<tr><td colspan="2">Literature Collection</td><td>10</td><td rowspan="4">40</td></tr>
<tr><td colspan="2">Data Collection</td><td>10</td></tr>
<tr><td colspan="2">Methodology</td><td>10</td></tr>
<tr><td colspan="2">Presentation of Result</td><td>10</td></tr>
</table>

## 17. Question Paper Pattern

**Bloom's Taxonomy Based Assessment Pattern**

**(K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate)

**(i)** (CIA I, CIA II & Revision Examinations = 25 Marks and ESE = 75 Marks)

| Knowledge Level | Parts | Marks | Description | Marks |
|---|---|---|---|---|
| K1 & K2 | A (Answer ALL) Q1–Q15 | 15 × 1 = 15 | Multiple Choice Questions (MCQ) (Three questions from each unit) | 15 |
| K2 & K3 | B (Answer any THREE out of FIVE) Q16–Q20 | 3 × 5 = 15 | Short Answers (One question from each unit) | 15 |
| K3, K4 & K5 | C Answer ALL (Either or Pattern) Q21–Q25 | 5 × 9 = 45 | Descriptive/Detailed Answers (Two questions from each unit) | 45 |
| **Total Marks** | | | | **75** |

Passing Minimum (CIA) 50% = 12 Marks

Passing Minimum (ESE) 50% = 38 Marks

**50 Marks**

**(ii) Project Viva-Voce (Progress Report = 25 Marks and ESE = 75 Marks)**

| Knowledge Level | Component | Marks | Total Marks |
|---|---|---|---|
| K3, K4 & K5 | Progress Report | 25 | 100 |
| | Project Dissertation & Viva-voce | 75 | |

Passing Minimum (CIA) 50% = 20 Marks

Passing Minimum (ESE) 50% = 30 Marks

**50 Marks**

The candidate shall be declared to have passed the examination if the candidates secure not less than 38 marks out of 75 marks in the semester examination in each theory course and 12 marks out of 25 marks in the CIA and in total not less than 50 marks.

For the practical course, 30 marks out of 60 marks in the semester examination and the record notebook taken together and 20 marks out of 40 marks in the CIA and in total 50 marks. There is no passing minimum for the record notebook. However, submission of the record notebook is necessary.

For the project work and Viva-voce, a candidate should secure 50% of the marks for pass. The candidate should compulsorily attend the Viva-voce examination to secure a pass in the project.

Candidate who does not obtain the required minimum marks for a pass in a Course/Practical/Project/Dissertation shall be declared Re-Appear (RA) and the candidate has to appear and pass the same at a subsequent appearance.

**18. Dissertation**

(a) Topic: The topic of the dissertation shall be assigned to the candidate before the beginning of third semester and a copy of the same should be submitted to the Department Approval.

(b) Number of Project/Dissertation copies to be submitted by the students

The students should prepare three copies of dissertation and submit the same for the evaluation by Examiners. After evaluation, one copy is to be retained in the College Library and one copy is to be submitted to the COE and the student can have the rest.

(c) Format to be followed

The format of the Project/Dissertation to be prepared and submitted by the students in Semester IV is given below:

**Format for the preparation of Project Work:**

**(i) Title Page:**

**TITLE OF THE PROJECT/DISSERTATION**

Project/Dissertation Submitted in partial fulfilment of the requirement for the award of the Degree of Master of Science in Mathematics (under Choice Base Credit System) to the Sri Vidya Mandir Arts & Science College (Autonomous)-Katteri,Uthangarai.

By

**(Student's Name)**
**(Register Number)**

Under the Guidance of
**(Guide Name and Designation)**

(College Logo)

**(Name of the Department)**

**(College Address)**
(Month and Year)

**(ii) Declaration by the Student**

**Name of the Student** _____

Register No. _____

PG & Research Department of Mathematics

Sri Vidya Mandir Arts & Science College (Autonomous)

Katteri – 636 902, Uthangarai, Krishnagiri District.

## Declaration by the Student

I hereby declare that the dissertation entitled _____ submitted by me for the award of **Master of Science (M.Sc.) Degree in Mathematics,** carried out in the **PG and Research Department of Mathematics, Sri Vidya Mandir Arts and Science College (Autonomous), Uthangarai, Krishnagiri – 636 902.**

**Date:**
**Place:** **Signature of the Student**

**(ii) Bonafide Certificate**

**Bonafied Certificate**

This is to certify that the dissertation entitled "……" submitted in partial fulfilment of the requirement of the award of the **Degree of Master of Science in Mathematics** (Under Choice Based Credit System) to the Sri Vidya Mandir Arts & Science College , is a record of bonafide research work carried out by …….. under my supervision and guidance and that no part of the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date:
Place:

**Signature of the Head of the Department** **Signature of the Guide**

**(iii) Acknowledgement**

(Drafted by the Student)

**(iv) Table of Contents**

| Chapter No. | Title | Page No. |
|---|---|---|
| 1 | Introduction | |
| 2 | Review of Literature | |
| 3 | Materials and Methods | |
| 4 | Results and Discussion | |
| 5 | Summary/Concuusion | |
| | References | |

**19. Maximum Duration for the Completion of the M.Sc.Mathematics Programme**

The maximum duration for completion of the M.Sc. Mathematics Programme shall not exceed eight semesters.

## 20. Commencement of this Regulation

This regulation and syllabus shall take effect from the academic year 2020–2021 for students who are admitted to the first year of the Programme during the academic year 2020–2021 and thereafter.

## 21. GRADING

Once the marks of the cumulative CIA and ESE are available, they will be added. The marks thus obtained will then be graded as per details given below:

### Marks and Grades

The following table gives the marks grade points, letter grades and classification to indicate the performance of the candidate.

| Range of Marks | Grade Points | Letter Grade | Description |
|---|---|---|---|
| 90–100 | 9.0–10.0 | O | Outstanding |
| 80–89 | 8.0–8.9 | D+ | Excellent |
| 75–79 | 7.5–7.9 | D | Distinction |
| 70–74 | 7.0–7.4 | A+ | Very Good |
| 60–69 | 6.0–6.9 | A | Good |
| 50–59 | 5.0–5.9 | B | Average |
| 00–49 | 0.0 | U | Re-appear |
| ABSENT | 0.0 | AAA | ABSENT |

Ci = Credits earned for course i in any semester

Gi = Grade Point obtained for course i in any semester

n = Semester in which such course were credited

### Grade point average (for a Semester)

**Calculation of grade point average semester-wise and part-wise is as follows:**

GRADE POINT AVERAGE [GPA] = $\Sigma i\ Ci\ Gi\ /\ \Sigma i\ Ci$

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the courses under each part}}{\text{Sum of the credits of the courses under each part in a semester}}$$

**Calculation of Grade Point Average (CGPA) (for the entire programme)**

A candidate who has passed all the examinations under different parts is eligible for the following part wise computed final grades based on the range of CGPA.

CUMULATIVE GRADE POINT AVERAGE [CGPA] = $\Sigma n\ \Sigma i\ Cni\ Gni\ /\ \Sigma n\ \Sigma i\ Cni$

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the entire program under each part}}{\text{Sum of the credits of the courses of the entire program under each part}}$$

## 22. Classification of Successful Candidates

A candidate who passes all the examinations and securing following CGPA and Grades shall be declared as follows:

| CGPA | GRADE | CLASSIFICATION OF FINAL RESULT |
|---|---|---|
| 9.5–10.0 | O+ | First Class – Exemplary |
| 9.0 and above but below 9.5 | O | |
| 8.5 and above but below 9.0 | D++ | First Class with Distinction |
| 8.0 and above but below 8.5 | D+ | |
| 7.5 and above but below 8.0 | D | |
| 7.0 and above but below 7.5 | A++ | First Class |
| 6.5 and above but below 7.0 | A+ | |
| 6.0 and above but below 6.5 | A | |
| 5.5 and above but below 6.0 | B+ | Second Class |
| 5.0 and above but below 5.5 | B | |

## 23. Ranking

A candidate who qualifies for the M.Sc. Mathematics, passing all the Examinations in the first attempt within the minimum period prescribed for the Programme from the date of admission to the Programme and secures first or second class shall be eligible for ranking and such ranking will be confined to 10% of the total number of candidates qualified in that particular subject to a maximum of 10 ranks.

**24. Conferment of the Degree**

No candidate shall be eligible for conferment of the Degree unless he/she has undergone the prescribed Programme of study for a period of not less than four Semesters in an Institution and earns has passed the Examinations as have been prescribed.

**25. Transitory Provision**

Candidates who have undergone the Programme of Study prior to the Academic Year 2023-2024 will be permitted to take the Examinations under those Regulations for a period of four years i.e. up to and inclusive of the Examination of April 2024. Thereafter, they will be permitted to take the Examination only under the Regulations in force at that time.

# SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE

**(Autonomous)**

## Master of Science (M.Sc.) in Mathematics

## Programme Pattern and Syllabus (CBCS)

**Credit Distribution for PG Programme**

| Semester–I | Credit | Semester-II | Credit | Semester-III | Credit | Semester–IV | Credit |
|---|---|---|---|---|---|---|---|
| 1.1. Core-I | 5 | 2.1. Core-IV | 5 | 3.1. Core-VII | 5 | 4.1. Core-XI | 5 |
| 1.2 Core-II | 5 | 2.2 Core-V | 5 | 3.2 Core-VIII | 5 | 4.2 Core-XII | 5 |
| 1.3 Core – III | 4 | 2.3 Core – VI | 4 | 3.3 Core – IX | 5 | 4.3 Project with Viva-Voce | 7 |
| 1.4 Elective (Generic / Discipline Centric)- I | 3 | 2.4 Elective (Generic / Discipline Centric) – III | 3 | 3.4 Core – X Industry Module (Machine Learning) | 4 | 4.4 Elective (Generic / Discipline Centric) – VI | 3 |
| 1.5 Elective (Generic / Discipline Centric)-II | 3 | 2.5 Elective (Generic / Discipline Centric)-IV | 3 | 3.5 Elective (Generic / Discipline Centric) – V | 3 | 4.5 Skill Enhancement Course - Professional Competency Skill | 2 |
| | | 2.6 NME-I | 2 | 3.6 NME-II | 2 | 4.6 Extension Activity | 1 |
| | | 2.7 Fundamentals of Human Rights | 1 | 3.7 Internship/ Industrial Activity | 2 | | |
| | **20** | | **23** | | **26** | | **23** |
| | | | | | | **Total Credit Points** | **92** |

**Core - Papers = 57**

**Elective (Generic / Discipline Centric) = 18**

**Skill Enhancement Course = 02**

**NME(I & II) = 04**

**Fundamentals of Human Rights = 01**

**Internship / Industrial Activity = 02**

**Project Viva Voce = 07**

**Extension Activity = 01**

**Total Credits 92**

**Component wise Credit Distribution**

| Credits | Sem I | Sem II | Sem III | Sem IV | Total |
|---|---|---|---|---|---|
| **Part A** | **14** | **14** | **19** | **17** | **64** |
| **Part B**<br>**(i) Discipline – Centric / Generic Skill** | **6** | **6** | **3** | **3** | **18** |
| **(ii) Soft Skill** | - | - | - | **2** | **4** |
| **(iii) Summer Internship / Industrial Training** | - | - | **2** | - | |
| **Part C** | | **3** | **2** | **1** | **6** |
| **Total** | **20** | **23** | **26** | **23** | **92** |

**Part A component and Part B (i) will be taken into account for CGPA calculation for the postgraduate programme and the other components Part B and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree**

**M.Sc., Mathematics**

**Programme Specific Outcomes:**

**PSO1:** Acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & statistics.

**PSO2:** Understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.

**PSO3:** To prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions.

To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.

To encourage practices grounded in research that comply with employment laws, leading the organization towards growth and development.

**Mapping of Course Learning Outcomes (CLOs)** with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)can be carried out accordingly, assigning the appropriate level in the grids:

| | Pos | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | … | 1 | 2 | … |
| CLO1 | | | | | | | | | | |
| CLO2 | | | | | | | | | | |
| CLO3 | | | | | | | | | | |
| CLO4 | | | | | | | | | | |
| CLO5 | | | | | | | | | | |

**2 b. Structure of Course**

| **Course Code** | **Course Name** | | **Credits** |
|---|---|---|---|
| **Lecture Hours: (L) per week** | **Tutorial Hours : (T) per week** | **Lab Practice Hours: (P)per week** | **Total: (L+T+P) per week** |
| **Course Category :** | **Year & Semester:** | | **Admission Year:** |
| **Pre-requisite** | | | |
| **Links to other Courses** | | | |
| **Learning Objectives:** (for teachers: what they have to do in the class/lab/field) | | | |
| **Course Outcomes:** (for students: To know what they are going to learn)<br>**CO1:**<br>**CO2:**<br>**CO3:**<br>**CO4:**<br>**CO5:** | | | |
| **Recap:** (not for examination) Motivation/previous lecture/ relevant portions required for the course) [ This is done during 2 Tutorial hours) | | | |

| **Units** | **Contents** | **Required Hours** |
|---|---|---|
| **I** | | **18** |
| **II** | | **18** |
| **III** | | **18** |
| **IV** | | **18** |
| **V** | | **18** |
| Extended Professional | Questions related to the above topics, from | |

| | | |
|---|---|---|
| Component (is a part of internal component only, Not to be included in the External Examination question paper) | various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved<br>(To be discussed during the Tutorial hour) | |
| Skills acquired from the course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |
| **Learning Resources:**<br>• **Recommended Texts**<br>• **Reference Books**<br>• **Web resources** | | |
| **Board of Studies Date:** | | |

**3. Learning and Teaching Activities**

**3.1 Topic wise Delivery method**

| Hour Count | Topic | Unit | Mode of Delivery |
|---|---|---|---|
| | | | |

**3.2 Work Load**

The information below is provided as a guide to assist students in engaging appropriately with the course requirements.

| Activity | Quantity | Workload periods |
|---|---|---|
| Lectures | 60 | 60 |
| Tutorials | 15 | 15 |
| Assignments | 5 | 5 |
| Cycle Test or similar | 2 | 4 |
| Model Test or similar | 1 | 3 |
| University Exam Preparation | 1 | 3 |
| Total | | 90 periods |

1. **Tutorial Activities**

| Tutorial Count | Topic |
|---|---|
| | |

2. **Laboratory Activities**
3. **Field Study Activities**
4. **Assessment Activities**

## Assessment Principles:

Assessment for this course is based on the following principles

1. Assessment must encourage and reinforce learning.
2. Assessment must measure achievement of the stated learning objectives.
3. Assessment must enable robust and fair judgments about student performance.
4. Assessment practice must be fair and equitable to students and give them the opportunity to demonstrate what they learned.
5. Assessment must maintain academic standards.

**Assessment Details:**

| Assessment Item | Distributed Due Date | Weig htage | Cumulative Weightage |
|---|---|---|---|
| Assignment 1 | 3rd week | 2% | 2% |
| Assignment 2 | 6th Week | 2% | 4% |
| Cycle Test – I | 7th Week | 6% | 10% |
| Assignment 3 | 8th Week | 2% | 12% |
| Assignment 4 | 11th Week | 2% | 14% |
| Cycle Test – II | 12th Week | 6% | 20% |
| Assignment 5 | 14th Week | 2% | 22% |
| Model Exam | 15th Week | 13% | 35% |
| Attendance | All weeks as per the Academic Calendar | 5% | 40% |
| University Exam | 17th Week | 60% | 100% |

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System**

# Post – Graduate Courses including Lab Hours

## First Year – Semester – I

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core – I | 5 | 6 |
| | Core – II | 5 | 6 |
| | Core – III | 4 | 6 |
| | Elective – I | 3 | 6 |
| | Elective – II | 3 | 6 |
| | | **20** | **30** |

## Semester-II

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core – IV | 5 | 6 |
| | Core – V | 5 | 5 |
| | Core – VI | 4 | 5 |
| | Elective – III | 3 | 4 |
| | Elective – IV | 3 | 4 |
| | NME - I | 2 | 4 |
| | Fundamentals of Human Rights | 1 | 2 |
| | | **23** | **30** |

**Second Year – Semester – III**

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core – VII | 5 | 6 |
| | Core – VIII | 5 | 6 |
| | Core – IX | 5 | 6 |
| | Core (Industry Module) – X | 4 | 6 |
| | Elective – V | 3 | 3 |
| | NME - II | 2 | 3 |
| | Internship / Industrial Activity [Credits] | 2 | - |
| | | **26** | **30** |

**Semester-IV**

| Part | List of Courses | Credits | No. of Hours |
|---|---|---|---|
| | Core – XI | 5 | 6 |
| | Core – XII | 5 | 6 |
| | Project with VIVA VOCE | 7 | 6 |
| | Elective – VI (Industry Entrepreneurship) | 3 | 6 |
| | Skill Enhancement Course [SEC] / Professional Competency Skill | 2 | 6 |
| | Extension Activity | 1 | - |
| | | **23** | **30** |

**Total 92 Credits for PG Courses**

## Credit Distribution for PG Programme in Mathematics

## M.Sc., Mathematics

**Illustration – I**

| | **First Year Semester-I** | **Credit** | **Hours per week** |
|---|---|---|---|
| Part A | CC1 - Algebraic Structures | 5 | 6 |
| | CC2 - Real Analysis I | 5 | 6 |
| | CC3 - Ordinary Differential Equations | 4 | 6 |
| | Elective I(Generic / Discipline Specific)(One from Group A) | 3 | 6 |
| | Elective II(Generic / Discipline Specific)(One from Group B) | 3 | 6 |
| | **Total** | **20** | **30** |

| | **Semester-II** | **Credit** | **Hours per week** |
|---|---|---|---|
| Part A | CC4 – Advanced Algebra | 5 | 6 |
| | CC5 – Real Analysis II | 5 | 5 |
| | CC6 - Partial Differential Equations | 4 | 5 |
| | (i) Elective III (Generic / Discipline Specific)(One from Group C) | 3 | 5 |
| | (ii) Elective-IV(Generic / Discipline Specific) (One from Group D) | 3 | 5 |
| Part B | NME-I | 2 | 2 |
| | Fundamentals of Human Rights | 1 | 2 |
| | **Total** | **23** | **30** |

| | Second Year - Semester-III | Credit | Hours per week |
|---|---|---|---|
| Part A | CC7 - Complex Analysis | 5 | 6 |
| | CC8 - Probability Theory | 5 | 6 |
| | CC9 – Topology | 5 | 6 |
| | CC10 – Industry Module | 4 | 5 |
| | Elective V(Generic / Discipline Specific)(One from Group E) | 3 | 5 |
| Part B | NME-II | 2 | 2 |
| | Internship / Industrial Activity<br>(Carried out in Summer Vacation at the end of I year – 30 hours) | 2 | |
| | **Total** | **26** | **30** |

| | Semester-IV | Credit | Hours per week |
|---|---|---|---|
| Part A | CC11–Functional Analysis | 5 | 6 |
| | CC12 - Differential Geometry | 5 | 6 |
| | Project with viva voce | 7 | 6 |
| | Elective VI(Generic / Discipline Specific)(One from Group F) | 3 | 6 |
| Part B | Professional Competency Skill Enhancement Course<br>(from Group G)<br>Training for Competitive Examinations<br>• Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours)<br>• General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours)<br>OR Mathematics for Advanced Research Studies (4 hours) | 2 | 6 |
| Part C | Extension Activity | 1 | |
| | **Total** | **23** | **30** |

**TOTAL CREDITS: 92**

**Credit Distribution for PG Programme in Mathematics**

**M.Sc Mathematics**

**Illustration – I**

| | **First Year Semester-I** | **Credit** | **Hours per week(L/T/P)** |
|---|---|---|---|
| Part A | CC1 - Algebraic Structures | 5 | 6( 5L + 1T ) |
| | CC2 - Real Analysis I | 5 | 6( 5L + 1T ) |
| | CC3 - Ordinary Differential Equations | 4 | 6( 5L + 1T ) |
| | Elective I(Generic / Discipline Specific)(One from Group A) | 3 | 6( 5L + 1T ) |
| | Elective II(Generic / Discipline Specific)(One from Group B) | 3 | 6( 5L + 1T ) |
| | **Total** | **20** | **30** |

| | **Semester-II** | **Credit** | **Hours per week(L/T/P)** |
|---|---|---|---|
| Part A | CC4 – Advanced Algebra | 5 | 6( 5L + 1T ) |
| | CC5 – Real Analysis II | 5 | 5( 4L + 1T ) |
| | CC6 - Partial Differential Equations | 4 | 5( 4L + 1T ) |
| | Elective III (Generic / Discipline Specific)(One from Group C) | 3 | 5( 3L + 1T ) |
| | Elective-IV(Computer / IT related) (One from Group D) | 3 | 5(3L+ 2 P) |
| Part B | NME - I | 2 | 2 |
| | Fundamentals of Human Rights | 1 | 2 |
| | **Total** | **23** | **30** |

| | Second Year Semester-III | Credit | Hours per week(L/T/P) |
|---|---|---|---|
| Part A | CC7 - Complex Analysis | 5 | 6( 5L + 1T ) |
| | CC8 - Probability Theory | 5 | 6( 5L + 1T ) |
| | CC9 – Topology | 5 | 6( 5L + 1T ) |
| | CC10- Industry Module | 4 | 5( 4L + 1T ) |
| | Elective V(Generic / Discipline Specific)(One from Group E) | 3 | 5( 4L + 1T ) |
| Part B | Internship / Industrial Activity<br>(Carried out in Summer Vacation at the end of I year – 30 hours) | 2 | |
| | NME - II | 2 | 2 |
| | **Total** | **26** | **30** |

| | Semester-IV | Credit | Hours per week (L/T/P) |
|---|---|---|---|
| Part A | CC11–Functional Analysis | 5 | 6( 5L + 1T ) |
| | CC12 - Differential Geometry | 5 | 6( 5L + 1T ) |
| | CC13 - Core Project with viva voce | 7 | 6 |
| | Elective VI (Generic / Discipline Specific)(One from Group F) | 3 | 6( 5L + 1T ) |
| Part B | Professional Competency Skill Enhancement Course<br>Training for Competitive Examinations<br>• Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours)<br>• General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours) (OR)<br>Mathematics for Advanced Research Studies (4 hours) | 2 | 6 |
| Part C | Extension Activity | 1 | |
| | **Total** | **23** | **30** |

**TOTAL CREDITS: 93**

**Consolidated Table for Credits Distribution**

| | Category of \Courses | Credits for each Course | Number of Courses | Number of Credits in each Category of Courses | Total Credits | Total Credits for the Programme |
|---|---|---|---|---|---|---|
| PART A | Core (i) | 5 | 9 | 45 | 82 | 89 (CGPA) |
| | (ii) | 4 | 2 | 8 | | |
| | Project with viva voce | 7 | 1 | 7 | | |
| | Industry aligned Programmes- | 4 | 1 | 4 | | |
| | Elective (Generic and Discipline Centric) | 3 | 6 | 18 | | |
| PART B (i) | Skill Enhancement (Term paper and Seminar & Generic / Discipline - Centric Skill Courses) (Internal Assessment Only) | 2 | 1 | 2 | 2 | |
| (ii) | NMEC-I, II | 2 | 2 | 4 | 4 | |
| (iii) | Fundamentals of Human Rights | 1 | 1 | 1 | 1 | |
| (iv) | Summer Internship | 2 | 1 | 2 | 2 | 3 |
| PART C | Extension Activity | 1 | 1 | 1 | 1 | |
| | | | | | **Total Credits** | **92** |

**Template for Semester**

| Code | Category | Title of the Paper | Marks (Max 100) | | Duration for UE | Credits |
|---|---|---|---|---|---|---|
| | | | CIA | UE | | |
| **Semester –I** | | | | | | |
| Part A | Core I | | 25 | 75 | 6 Hrs | 5 |
| | Core II | | 25 | 75 | 6 Hrs | 5 |
| | Core III | | 25 | 75 | 6 Hrs | 4 |
| | Elective I | Elective-I (Choose one from Group-A) | 25 | 75 | 6 Hrs | 3 |
| | Elective II | Elective-I I (Choose one from Group-B) | 25 | 75 | 6 Hrs | 3 |
| **Semester-II** | | | | | | |
| Part A | Core IV | | 25 | 75 | 6 Hrs | 5 |
| | Core V | | 25 | 75 | 5 Hrs | 5 |
| | Core VI | | 25 | 75 | 5 Hrs | 4 |
| | Elective III | Elective-III (Choose one from Group-C) | 25 | 75 | 5 Hrs | 3 |
| | Elective IV | Elective-IV (Choose one from Group-D) | 25 | 75 | 5 Hrs | 3 |
| Part B | NME – I | | 25 | 75 | 3Hrs | 2 |
| | Fundamentals of Human Rights | | 25 | 75 | 3Hrs | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Semester-III** | | | | | | |
| Part A | Core VII | | 25 | 75 | 6 Hrs | 5 |
| | Core VIII | | 25 | 75 | 6 Hrs | 5 |
| | Core IX | | 25 | 75 | 6 Hrs | 5 |
| | Elective / ED V | Elective-VI /ED-V (Choose one from Group-E) | 25 | 75 | 5 Hrs | 3 |
| | Core X (Industry Module) | ED-IV (Choose from outside the Department) | 25 | 75 | 5 Hrs | 4 |
| Part B | NME - II | | | | | 2 |
| | Internship / Industrial - Vacation Activity | | | | | 2 |
| **Semester-IV** | | | | | | |
| Part A | Core X | | 25 | 75 | 6 Hrs | 5 |
| | Core XI | | 25 | 75 | 6 Hrs | 5 |
| | Project with viva voce XII | | 25 | 75 | 6 Hrs | 7 |
| | Elective VI | Elective-VI (Choose one from Group – F) | 25 | 75 | 6 Hrs | 3 |
| Part B | Professional Competency Skill Enhancement Course | (from Group G) | 25 | 75 | 6Hrs | 2 |
| Part C | Extension Activity | Performance based assessment | | | | 1 |
| **Total Credits** | | | | | | **92** |

# Elective Courses

**Courses are grouped (Group A to Group F) so as to include topics from Pure Mathematics(PM), Applied Mathematics(AM), Industrial Components(IC) and IT Oriented(ITC) courses for flexibility of choice by the stakeholders / institutions.**

**Semester I : Elective I and Elective II**

**Elective I** to be chosen from Group A and **Elective II** to be chosen from Group B

**Group A: (PM/AP/IC/ITC)**

1. Number Theory and Cryptography
2. Graph Theory and Applications
3. Formal Languages and Automata Theory
4. Programming in C++ and Numerical Methods

**Group B:(PM/AP/IC/ITC)**

1. Lie Groups and Lie Algebras
2. Mathematical Programming
3. Fuzzy Sets and Their Applications
4. Discrete Mathematics

**Semester II : Elective III & Elective IV**

**Elective III** to be chosen from **Group C** and **Elective IV** to be chosen from **Group D**

**Group C:(PM/AP/IC/ITC)**

1. Algebraic Topology
2. Mathematical Statistics
3. Statistical Data Analysis using R Programming
4. Tensor Analysis and Relativity

**Group D :(PM/AP/IC/ITC)**

1. Wavelets
2. Modeling and Simulation with Excel
3. Machine Learning and Artificial Intelligence
4. Neural Networks

**Semester III : Elective V**

**Elective V** to be chosen from Group E.

**Group E: (PM/AP/IC/ITC)**

1. Algebraic Number Theory
2. Fluid Dynamics
3. Stochastic Processes
4. Mathematical Python

**Semester IV : Elective VI**

**Elective VI** to be chosen from Group F.

**Group F:(PM/AP/IC/ITC)**

1. Algebraic Geometry
2. Financial Mathematics
3. Resource Management Techniques
4. Mathematical Python

**Skill Enhancement Courses**

**Skill Enhancement Courses are chosen so as to keep in pace with the latest developments in the academic / industrial front and provides flexibility of choice by the stakeholders / institutions.**

**Group G (Skill Enhancement Courses) SEC:**

- Computational Mathematics using SageMath
- Mathematical documentation using LATEX / other packages
- Office Automation and ICT Tools
- Numerical analysis using SCILAB
- Differential equations using SCILAB
- Industrial Mathematics /Statistics using latest programming packages
- Research Tools and Techniques

**Extra Disciplinary Courses for other Departments (not for Mathematics students)**

- Students from other Departments may also choose any one of the following as Extra Disciplinary Course.
- ED-I: Mathematics for Life Sciences
- ED-II: Mathematics for Social Sciences
- ED-III: Statistics for Life and Social Sciences
- ED-IV: Game Theory and Strategy
- ED-V: History of Mathematics

**Instructions for Course Transaction**

| Courses | Lecture hrs | Tutorial hrs | Lab Practice | Total hrs |
|---|---|---|---|---|
| Core | 75 | 15 | -- | 90 |
| Electives | 75 | 15 | -- | 90 |
| ED | 75 | 15 | -- | 90 |
| Project | 20 | -- | 70 | 90 |

**Testing Pattern (25+75)**

**Internal Assessment**

**Theory Course:** For theory courses there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.

**Computer Laboratory Courses:** For Computer Laboratory oriented Courses, there shall be two tests in Theory part and two tests in Laboratory part. Choose one best from Theory part and other best from the two Laboratory part. The average of the best two can be treated as the CIA for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.

There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examination.

**Written Examination: Theory Paper (Bloom's Taxonomy based)**

**Question paper Model**

| | |
|---|---|
| **Intended Learning Skills** | **Maximum 75 Marks**<br>**Passing Minimum: 50%**<br>**Duration : Three Hours** |
| | **Part –A (15 x 1 = 15 Marks)**<br>Answer ALL questions<br>**Each Question carries 1 mark** |
| Memory Recall / Knowledge about the Concepts/ Understanding | Three questions from each UNIT |
| | **Question 1 to Question 15** |
| | **Part – B (3 x 5 = 15 Marks)**<br>**Answer any THREE questions**<br>**Each questions carries 5 Marks** |
| Descriptions/ Application<br>(problems) | There shall be FIVE questions covering all the five units |
| | **Question 16 to Question 20** |
| | **Part-C (5 x 9 = 45 Marks)**<br>**Answer ALL THE questions**<br>**Each question carries 9 Marks** |
| Analysis /Synthesis / Evaluation | **Either-or Type**<br>Both parts of each question from the same UNIT |
| | **Question 21 to Question 25** |

Each question should carry the course outcome and cognitive level

For instance,

1. [CO1 : K2] Question xxxx
2. [CO3 : K1] Question xxxx

**Different Types of Courses**

**(i) Core Courses (Illustrative)**

1. Algebraic Structures - **24PMA1C01**
2. Real Analysis - I - **24PMA1C02**
3. Ordinary Differential Equations - **24PMA1C03**
4. Advanced Algebra - **24PMA2C04**
5. Real Analysis - II - **24PMA2C05**
6. Partial Differential Equations - **24PMA2C06**
7. Complex Analysis - **24PMA3C07**
8. Probability Theory - **24PMA3C08**
9. Topology - **24PMA3C09**
10. Industry Module(ML) - **24PMA3C10**
11. Functional Analysis - **24PMA4C11**
12. Differential Geometry - **24PMA4C12**

**(ii) Elective Courses (ED within the Department Experts) (Illustrative)**

1. Number Theory and Cryptography - **24PMA1E01**
2. Graph theory and Applications - **24PMA1E02**
3. Formal Languages and Automata Theory - **24PMA1E03**
4. Programming in C++ and Numerical Methods - **24PMA1E04**
5. Lie Groups and Lie Algebras - **24PMA1E05**
6. Mathematical Programming - **24PMA1E06**
7. Fuzzy Sets and Their Applications - **24PMA1E07**
8. Discrete Mathematics - **24PMA1E08**
9. Algebraic Topology - **24PMA2E09**
10. Mathematical Statistics - **24PMA2E10**
11. Statistical Data Analysis Using R-Programming- **24PMA2E11**
12. Tensor Analysis and Relativity - **24PMA2E12**
13. Wavelets - **24PMA2E13**
14. Modeling And Simulation With Excel - **24PMA2E14**
15. Machine Learning and Artifical Intelligence - **24PMA2E15**

16. Neural Networks - **24PMA2E16**
17. Algebraic Number Theory - **24PMA3E17**
18. Fluid Dynamics - **24PMA3E18**
19. Stochastic Processes - **24PMA3E19**
20. Mathematical Python - **24PMA3E20**
21. Algebraic Geometry - **24PMA4E21**
22. Financial Mathematics - **24PMA4E22**
23. Resource Management Techniques - **24PMA4E23**

**(iii) Extra Disciplinary Courses for other Departments (not for Mathematics students)**

1. ED-I: Mathematics for Life Sciences - **24PMAED01**
2. ED-II: Mathematics for Social Sciences - **24PMAED02**
3. ED-III:Statistics for Life and Social Sciences- **24PMAED03**
4. ED-IV: Game Theory and Strategy - **24PMAED04**
5. ED-V: History of Mathematics - **24PMAED05**

**(iv) Skill Enhancement Courses (SEC)**

1. Computational Mathematics using Sage Math - **24PMASEC01**
2. Mathematical documentation using LATEX - **24PMASEC02**
3. Office Automation and ICT Tools - **24PMASEC03**
4. Numerical analysis using SCILAB - **24PMASEC04**
5. Differential equations using SCILAB - **24PMASEC05**
6. Industrial Mathematics /Statistics using latest programming packages - **24PMASEC06**
7. Research Tools and Techniques - **24PMASEC07**

**(v) NME – I & II (Select from Other Department)**

1. Fundamentals of Computers and Communications (NME-I) - **24PCS2EDC02**
2. நூலகவியல் (NME-II) - **24PTA3S02**

**(vi) Fundamentals of Human Rights** - **24P2HR01**

**(vii) Internship** - **24PMA3IN01**

**Syllabus for different Courses of M.Sc Mathematics**

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-I** | **Course Code:24PMA1C01** | | **Course Title:** Algebraic Structures | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 5 | 100 |

**Course Objectives**

To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms

**UNIT I :**

Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only). Chapter 2: Sections 2.11 and 2.12 (Omit Lemma 2.12.5)

**UNIT II:**

Solvable groups - Direct products - Finite abelian groups- Modules .Chapter 5 : Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1), Chapter 2: Section 2.13 and 2.14,(Theorem 2.14.1 only). Chapter 4: Section 4.5.

**UNIT-III :**

Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations. Chapter 6: Sections 6.4, 6.5

**UNIT-IV :**

Jordan form - rational canonical form. Chapter 6 : Sections 6.6 and 6.7.

**Unit V:**

Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form. Chapter 6 : Sections 6.8, 6.10 and 6.11 (Omit 6.9)

**Text Book:**

I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.

**Reference Books:**

1. M.Artin, *Algebra*, Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999

4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.
5. N.Jacobson, *Basic Algebra*, Vol. I & II W.H.Freeman (1980); also published by Hindustan Publishing Company, New Delhi.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org, www.algebra.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups

**CLO 2:** Define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules

**CLO 3:** Define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nilpotent transformation relating nilpotence with invariants.

**CLO 4:** Define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.

**CLO 5:** Define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to verify whether the transformation in Hermitian, unitary and normal

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-II** | **Course Code:24PMA1C02** | | **Course Title:** Real Analysis I | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 5 | 100 |

## Course Objectives

To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.

**Unit I : Functions of bounded variation**

Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation. Chapter – 6 : Sections 6.1 to 6.8

**Infinite Series :**

Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series. Chapter 8 : Sections 8.8, 8.15, 8.17, 8.18

**Unit II: The Riemann - Stieltjes Integral**

Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems. Chapter - 7 : Sections 7.1 to 7.14.

**UNIT-III : The Riemann-Stieltjes Integral**

Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable - Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter- Differentiation under integral sign-Lebesgue criteriaon for existence of Riemann integrals. Chapter - 7 : 7.15 to 7.26.

**UNIT-IV : Infinite Series and infinite Products**

Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products. Chapter - 8 Sec, 8.20, 8.21 to 8.26

**Power series:** Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem. Chapter 9 : Sections 9.14 9.15, 9.19, 9.20, 9.22, 9.23

**UNIT-V: Sequences of Functions**

Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. Chapter -9 Sec 9.1 to 9.6, 9.8,9.9,9.10,9.11, 9.13

**Text Book:**

Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.

**Reference Books:**

1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976.

2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976.

3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991.

4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991.

5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964.

6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Analyze and evaluate functions of bounded variation and Rectifiable Curves.

**CLO2:** Describe the concept of Riemann-Stieltjes integral and its properties.

**CLO3**: Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.

**CLO4:** Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.

**CLO5:** Formulate the concept and properties of inner products, norms and measurable functions.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-III** | **Course Code: 24PMA1C03** | | **Course Title:** Ordinary Differential Equations | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 4 | 100 |

**Course Objectives**

To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations

**UNIT- I : Linear equations with constant coefficients**

Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two. Chapter 2: Sections 1 to 6

**UNIT- II: Linear equations with constant coefficients**

Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation- Algebra of constant coefficient operators. Chapter 2 : Sections 7 to 12.

**UNIT-III : Linear equation with variable coefficients**

Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation. Chapter : 3 Sections 1 to 8 ( Omit section 9).

**UNIT-IV : Linear equation with regular singular points**

Euler equation – Second order equations with regular singular points –Exceptional cases – Bessel Function. Chapter 4 : Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9).

**UNIT-V: Existence and uniqueness of solutions to first order equations**

Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem. Chapter 5 : Sections 1 to 6 ( Omit Sections 7 to 9)

**Text Book:**

E.A.Coddington, *A introduction to ordinary differential equations* (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.

**Reference Books:**

1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems*, John Wiley and sons, New York, 1967.
2. George F Simmons, *Differential equations with applications and historical notes*, Tata McGraw Hill, New Delhi, 1974.
3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965.
4. W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971
5. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001
6. B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations*, Narosa Publishing House, New Delhi, 2002.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Establish the qualitative behavior of solutions of systems of differential equations .

**CLO2:** Recognize the physical phenomena modeled by differential equations and dynamical systems.

**CLO3:** Analyze solutions using appropriate methods and give examples.

**CLO4:** Formulate Green's function for boundary value problems.

**CLO5:** Understand and use various theoretical ideas and results that underlie the mathematics in this course.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

## ELECTIVE COURSES

**Courses are grouped (Group A to Group F) so as to include topics from Pure Mathematics(PM), Applied Mathematics(AM), Industrial Components(IC) and IT Oriented(ITC) courses for flexibility of choice by the stakeholders / institutions.**

**Semester I : Elective I and Elective II**

**Elective I** to be chosen from Group A and **Elective II** to be chosen from Group B

| **Program: M.Sc. Mathematics** | | | | |
|---|---|---|---|---|
| **Elective-I** | | **Course Code: 24PMA1E01** | | **Course Title:** Number Theory And Cryptography |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

### Course Objectives

- To understand fundamental number-theoretic algorithms such as theEuclidean algorithm, the Chinese Remainder algorithm, binary powering, and algorithms for integer arithmetic.
- To understand fundamental algorithms for symmetric key and public-key cryptography.
- To understand the number-theoretic foundations of modern cryptography and the principles behind their security.

  To implement and analyze cryptographic and number-theoreticalgorithms.

**UNIT-I: Elementary Number Theory:**
Time Estimates for doing arithmetic – divisibility and Euclidean algorithm – Congruences – Application to factoring. Chapter 1.

**UNIT-II:** Introduction to Classical Crypto systems – Some simple cryptosystems – Enciphering matrices DES. Chapter 3

**UNIT-III:** Finite Fields, Quadratic Residues and Reciprocity (Chapter 2)

**UNIT-IV:** Public Key Cryptography. Chapter 4

**UNIT-V:** Primality, Factoring, Elliptic curves and Elliptic curve cryptosystems. (Chapter 5, sections 1,2,3 &5 (omit section 4), Chapter 6, sections 1& 2 only)

**Text Book:** Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, New York,1987.

**Reference Books:**

I. Niven and H.S.Zuckermann, An Introduction to Theory of Numbers (Edn. 3), Wiley Eastern Ltd., New Delhi,1976
2. David M.Burton, Elementary Number Theory, Brown Publishers, Iowa,1989
3. K.Ireland and M.Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, 1972.
4. N.Koblitz, Algebraic Aspects of Cryptography, Springer 1998.

**Website and e-Learning Source:**

1. https://nptel.ac.in/courses/111101137
2. https://archive.nptel.ac.in/courses/106/103/106103015/
3. https://onlinecourses-archive.nptel.ac.in/noc17_cs36/preview

**Course Learning Outcome (for Mapping with POs and PSOs**

Students will be able to

**CLO 1:** Illustratetheimplicationsof properties of divisibility and primes

**CLO 2:** Distinguish the DES and the AES.

**CLO 3:** Understanding the Law of Quadratic Reciprocity & Quadratic Residues.

**CLO 4:** Define the fundamentals of cryptography, such as encryption, Authentication anddigital signature.

**CLO 5:**Explain how elliptic curves are used in certain Crypto-graphic algorithms.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-I** | | **Course Code: 24PMA1E02** | **Course Title**: Graph Theory And Applications | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

**Course Objectives**

- Understand the basics of graph theory and their various properties.
- Model problems using graphs and to solve these problems algorithmically.
- Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.
- Optimize the solutions to real problems like transport problems etc.,

**UNIT- I : Basic Results**

Introduction-Basic Concepts-Subgraphs- Degrees of Vertices - Paths and Connectedness - Automorphism of a Simple Graph. (Chapter 1: Sections 1.1 - 1.6). Directed Graphs: Introduction-Basic Concepts-Tournaments.(Chapter 2 : Sections 2.1 - 2.3).

**UNIT- II: Connectivity and Trees**

Connectivity: Introduction-Vertex cut and Edge Cut-Connectivity and Edge Connectivity.(Chapter 3: Sections 3.1- 3.3). Trees: Introduction-Definition, Characterization andSimple Properties-Centers and Centroids- Cutting the Number of Spanning Trees-Cayley‘s Formula. (Chapter 4: Sections 4.1- 4.5).

**UNIT-III :**

Independent Sets, Matchings and Cycles: Independent Sets and Matchings: Introduction-Vertex-Independent Sets and Vertex Coverings-Edge-Independent sets-Matchings and Factors-Matchings in Bipartite Graphs. (Chapter 5: Sections 5.1- 5.5) . Cycles: Introduction- Eulerian GraphsHamiltonian Graphs. (Chapter 6: Sections 6.1- 6.3) .

**UNIT-IV : Graph Colorings**

Introduction-Vertex colorings-CriticalGraphs-Edge colorings of Graphs-Kirkman‘s Schoolgirl-Problem- Chromatic Polynomials.(Chapter 7: Sections 7.1 ,7.2 ,7.3 (7.2.1 & 7.2.3 only) ,7.6, 7.8, and 7.9).

**UNIT-V: Planarity**

Introduction- Planar and Nonplanar Graphs –Euler Formula and its Consequences $K_5$ and $K_{3,3}$ are Nonplanar Graphs – Dual of a Plane Graph- The Four-Color Theorem and Five- Color Theorem-Hamiltonian Plane Graphs-Tait Coloring.(Chapter 8: Sections 8.1 - 8.6 ,8.8 and 8.9).

**Text Book:**

R.Balakrishnan and K.Ranganathan, Text Book of Graph Theory, (2nd Edition), Springer, New York,2012.

**Reference Books:**

1. J.A.Bondy and U.S.R. Murty, Graph Theory with Applications, North Holland, New York, 1982.
2. Narasing Deo, Graph Theory with Application to Engineering and Computer Science, Prentice Hall of India, New Delhi. 2003.
3. F. Harary, Graph Theory, Addison – Wesely Pub. Co. The Mass. 1969.
4. L. R.. Foulds, Graph Theory Application, Narosa Publ. House, Chennai, 1933.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Understand and explore the basics of graph theory.

**CLO 2:** Analyse the significance of graph theory in different disciplines.

**CLO 3:** Demonstrate algorithms used in interdisciplinary domains.

**CLO 4:** Evaluate or synthesize any real world applications using graph theory.

**CLO 5:** Evaluate the different types of Graphs.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 |
| CLO3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-I** | | **Course Code: 24PMA1E03** | **Course Title**: Formal Languages And Automata Theory | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

**Course Objectives**

- To teach the student to identify different formal language classes andtheir relationships
- To teach the student the theoretical foundation for designingcompilers.
- To teach the student to use the ability of applying logical skills.
- Teach the student to prove or disprove theorems in automata theoryusing its properties.
- To teach the student the techniques for information processing.
- Understand the theory behind engineering applications.

**UNIT- I: Fundamentals**

Strings, Alphabet, Language, Operations, Finite state machine, definitions, finite automaton model, acceptance ofstrings, and languages, FA, transition diagrams and Language recognizers.

**Finite Automata:** Deterministic finite automaton, Non deterministic finite automaton and NFA with Є transitions - Significance, acceptance of languages. Conversions and Equivalence : Equivalence between NFA with and without Є transitions, NFA to DFA conversion, minimization of FSM, equivalence between two FSMs, Finite Automata with output- Moore and Melay machines.

**UNIT- II: Regular Languages**

Regular sets, regular expressions, identity rules, Conversion finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Pumping lemma of regular sets, closure properties of regular sets (proofs not required).

**UNIT-III : Context Free Grammars**

Ambiguity in context free grammars. Minimisation of Context Free Grammars. Chomsky normal form, Greibach normal form, Pumping Lemma for Context Free Languages. Enumeration of properties of CFL (proofs omitted).

**UNIT-IV : Push Down Automata**

Push down automata, definition, model, acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence. Equivalence of CFL and PDA, interconversion. (Proofs not required). Introduction to DCFL and DPDA. LINEAR BOUNDED AUTOMATA(LBA):LBA,context sensitive grammars ,CS languages.

**UNIT-V: Turing Machine**

Turing Machine, definition, model, design of TM, Computable functions, recursively enumerable languages.Church's hypothesis, counter machine, types of Turing machines (proofs not required).

**Computability Theory:** Chomsky hierarchy of languages, linear bounded automata and context sensitive language, LR(0) grammar, decidability of, problems, Universal Turing Machine, undecidability of posts. Correspondence problem, Turing reducibility, Definition of P and NP problems, NP complete and NP hard problems.

**Text Books:**

1. Introduction to Automata Theory Languages and Computation‖. Hopcroft H.E. and Ullman J. D. Pearson Education.
2. Introduction to Theory of Computation - Sipser 2nd editionThomson

**Reference Books:**

1. Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
2. Introduction to languages and the Theory of Computation ,John CMartin, TMH
3. Elements of Theory of Computation‖, Lewis H.P. & Papadimition C.H. Pearson /PHI.
4. Theory of Computer Science and Automata languages andcomputation -Mishra and Chandrashekaran, 2nd edition, PHI.
5. Theory of Computation, By K.V.N. Sunitha and N.Kalyani

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Student will have the ability to

**CLO 1:** Apply knowledge in designing or enhancing compilers.

**CLO 2:** Design grammars and automata (recognizers) for different language classes.

**CLO 3:** Apply knowledge in developing tools for language processing or text processing.

**CLO 4:** Make grammars to produce strings from a specific language.

**CLO 5:** Differentiate regular, context-free and recursively enumerable languages.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 |
| CLO3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-I** | **Course Code: 24PMA1E04** | | **Course Title**: Programming In C++ And Numerical Analysis | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

## Course Objectives

This courses introduces a higher level language C++ and numerical methods for hands-on experience on computers. Stress is also given on the error analysis.

**UNIT- I :**

Principles of OOP-Tokens-Expressions, Control Structures-Functions-Classes and Objects-constructors and destructors Chapter 1 to 6

**UNIT- II:**

Operator Overloading and type Conversions - Inheritance - Pointers, Virtual Functions and Polymorphism-Managing Console I/O Operations-Working with Files . Chapter 7 to 11

**UNIT-III : Finite Digit Arithmetic and Errors**

Floating point arithmetic - Propagated Error - Generated Error - Error in Evaluation of a function f(x). - Non-linear Equations: Bisection method- Secant Method - Regula Falsi Method - Newton‘s method - Muller‘s method - Fixed Point method - Chapters 1,2 : Only 2.1 to 2.6

**UNIT-IV : System of Linear Equations**

Gauss- Elimination Method - Crout‘s method - Inverse of a matrix - Condition numbers and errors - Jacobi‘s method - Gauss-Seidel Method - Relaxation method. Numerical Differentiation and Integration: Numerical Differentiation - Numerical Integration - Newton-Cotes Formulas - GaussianQuadrature - Double Integral Chapter 3 and 5 : 5.1 to 5.5 and 5.7 (omit 5.6)

**UNIT-V: Ordinary Differential Equations**

Difference equation -Differential Equations:Single Step method-Runge-Kutta Method- Multi-step methods Chapter 6: 6.1 to 6.4 (omit 6.5)

**Text Books:**

1. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill, New Delhi, 1999.
2. Devi Prasad, An Introduction to Numerical Analysis (3rd edn) Narosa Publishing House, New Delhi, 2006.

**Reference Books:**

1. D. Ravichandran, Programming with C++, Tata McGraw Hill, New Delhi, 1996
2. Conte and de Boor, Numerical Analysis, McGraw Hill, New York, 1990
3. John H.Mathews, Numerical Methods for Mathematics, Science and Engineering (2nd Edn.), Prentice Hall, New Delhi, 2000

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Student will have the ability to

**CLO 1:** Apply knowledge in designing or enhancing compilers.

**CLO 2:** Design grammars and automata (recognizers) for different language classes.

**CLO 3:** Apply knowledge in developing tools for language processing or text processing.

**CLO 4:** Make grammars to produce strings from a specific language.

**CLO 5:** Differentiate regular, context-free and recursively enumerable languages.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-II** | | **Course Code:24PMA1E05** | **Course Title**: Lie Groups And Lie Algebras | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

## Course Objectives

1. In physics, Lie groups appear as symmetry groups of physical systems, and their Lie algebras (tangent vectors near the identity)may be thought of as infinitesimal symmetry motions.
2. Lie algebras and their representations are used extensively in physics, notably in quantum mechanics and particle physics.

**UNIT- I :** Matrix Lie Groups. Chapter 1.

**UNIT- II:** The Matrix Exponential. Chapter 2.

**UNIT-III :** Lie Algebras. Chapter 3.

**UNIT-IV :** Basic Representation Theory. Chapter 4.

**UNIT-V:** Semisimple Lie Algebras. Chapter 7.

**Text Book:** .

1. Brain Hall, Lie Groups, Lie Algebras and Representations: An Elementary Introduction (Second Edition), Springer, USA, 2015.

**Reference Books:**

1. V. S. Varadarajan, Lie groups, Lie algebras and their representations,Sringer 1984.
2. Brian Hall, Lie groups, Lie algebras and representations, Springer2003.
3. Barry Simon, Representations of finite and compact groups, AMS1996.
4. A. W. Knapp, Representation theory of semismiple Lie groups. Anoverview based on examples, Princeton university press 2002.
5. S. Kumaresan S, A course in differential geometry and Lie groups, Texts and Readings in Mathematics, 22. Hindustan Book Agency,New Delhi, 2002.

**Website and e-Learning Source**

1. https://archive.nptel.ac.in/courses/111/108/111108134/
2. https://www.digimat.in/nptel/courses/video/111108134/L42.html

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Demonstrate systematic understanding of key aspects of Matrix Lie Groups and LieLie groups

**CLO 2:** Determine the exponential of a matrix.

**CLO 3:**Differentiate Lie groups and Lie Algebras

**CLO 4:** Find the representation of sl(2 ; C).

**CLO 5:** Explain reductive Lie algebra

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| CLO2 | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 1 | 1 |
| CLO3 | 3 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 2 |
| CLO4 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 |
| CLO5 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-II** | | **Course Code:24PMA1E06** | **Course Title**: Mathematical Programming | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

**Course Objectives**

This course introduces advanced topics in Linear and non-linear Programming.

**UNIT- I : Integer Linear Programming**

Types of Integer- Linear Programming Problems - Concept of Cutting Plane - Gomory's All Integer Cutting Plane Method - Gomory's mixed Integer Cutting Plane method - Branch and Bound Method. - Zero-One Integer Programming. Dynamic Programming: Characteristics of Dynamic Programming Problem - Developing Optimal Decision Policy - Dynamic Programming Under Certainty - DP approach to solve LPP. Chapter-7: 7.1 - 7.7 Chapter-20: 20.1 - 20.5

**UNIT- II: Classical Optimization Methods**

Unconstrained Optimization - Constrained Multi-variable Optimizationwith Equality Constraints - Constrained Multi-variable Optimization with inequality Constraints Non-linear Programming Methods: Examples of NLPP - General NLPP - Graphical solution - Quadratic Programming - Wolfe's modified Simplex Methods - Beale's Method Chapter-23: 23.1 - 23.4 Chapter-24: 24.1 - 24.4.

**UNIT-III : Theory Of Simplex Method**

Canonical and Standard form of LP - Slack and Surplus Variables - Reduction of any Feasible solution to a Basic Feasible solution - Alternative Optimal solution - Unbounded solution - Optimality conditions - Some complications and their resolutions - Degeneracy and its resolution. Chapter-25: 25.1 - 25.4, 25.6-25.9.

**UNIT-IV: Revised Simplex Method**

Standard forms for Revised simplex Method - Computational procedure for Standard form I - comparison of simplex method and Revised simplex Method. Bounded Variables LP problem: The simplex algorithm. Chapter-26: 26.1 - 26.4 Chapter-28: 28.1, 28.2.

**UNIT-V: Parametric Linear Programming**

Variation in the coefficients cj , Variations in the Right hand side, bi . Goal Programming: Difference between LP and GP approach - Concept of Goal Programming - Goal Programming Model formulation - Graphical Solution Method of Goal Programming - Modified Simplex method of Goal Programming. Chapter-29: 29.1 - 29.3.

**Text Book:**

.

1.J.K.Sharma, Operations Research, Theory and Applications, Third Edition (2007) Macmillan India Ltd.

**Reference Books:**

1. Hamdy A. Taha, Operations Research, (seventh edition) Prentice -Hall of India Private Limited, New Delhi, 1997.
2. F.S. Hillier & J.Lieberman Introduction to Operation Research (7thEdition) TataMcGraw Hill ompany, New Delhi, 2001.
3. Beightler. C, D.Phillips, B. Wilde ,Foundations of Optimization(2nd Edition) Prentice Hall Pvt Ltd., New York, 1979
4. S.S. Rao - Optimization Theory and Applications, Wiley Eastern Ltd. New Delhi. 1990

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com.

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Assess critically the utility of a number of mathematical programming techniques.

**CLO 2:** Describe mathematical programming solution strategies and techniques.

**CLO 3:** Use mathematical programming methods to address management decision problems.

**CLO 4:** Be able to design integrated business systems with a systems approach based on the business requirements by generating and developing multiple alternatives.

**CLO 5:** Can identify, analyze and develop solutions based on scientific evidence to Industrial Systems Engineering problems encountered in practice.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-II** | | **Course Code: 24PMA1E07** | **Course Title**: Fuzzy Sets And Their Applications | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

## Course Objectives

This course introduces advanced topics in Linear and non-linear Programming

**UNIT- I : Fuzzy sets**

Fuzzy sets – Basic types – Basic concepts - Characteristics – Significance of the paradigm shift – Additional properties of α - Cuts (Chapter 1: Sections 1.3 to 1.5 and Chapter 2: Sections 2.1)

**UNIT- II: Fuzzy Sets Versus CRISP Sets**

Representation of Fuzzy sets – Extension principle of Fuzzy sets – Operation on Fuzzy Sets – Types of Operation – Fuzzy complements. (Chapter 2: Sections 2.2 to 2.3 and Chapter 3: Sections 3.1 to 3.2)

**UNIT-III : Operations on Fuzzy Sets**

Fuzzy intersection – t-norms, Fuzzy unions – t conorms – Combinations of operations – Aggregationoperations. (Chapter 3: Sections 3.3 to 3.6)

**UNIT-IV : Fuzzy Arithmetic**

Fuzzy numbers – Linguistic variables – Arithmetic operation on intervals – Lattice of Fuzzy numbers. (Chapter 4: Sections 4.1 to 4.4)

**UNIT-V: Constructing Fuzzy Sets**

Methods of construction: An overview – Direct methods with one expert – Direct method with multiple experts – indirect method with multiple experts and one expert – Construction from sample data.(Chapter 10: Sections 10.1 to 10.7)

**Text Book:** .

G.J. Klir, and Bo Yuan, Fuzzy Sets and fuzzy Logic: Theory and Applications, Prentice Hall of India Ltd., New Delhi, 2005.

**Reference Books:**

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, AlliedPublishers, Chennai, 1996.
2. A.Kaufman, Introduction to the Theory of Fuzzy Subsets, AcademicPress, New York, 1975.
3. V.Novak, Fuzzy Sets and Their Applications, Adam Hilger, Bristol,1969.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Gain the main subject of fuzzy sets, learn crips and fuzzy set theory

**CLO 2:** Decide the difference between crips set and fuzzy set theory.

**CLO 3:** Recognize fuzzy logic membership function and fuzzy inference systems.

**CLO 4:** Make applications on Fuzzy logic membership function and fuzzy inference systems.

**CLO 5:** Make calculation on fuzy set theory.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-II** | | **Course Code:24PMA1E08** | **Course Title**: Discrete Mathematics | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| I | 6 | 90 | 3 | 100 |

## Course Objectives

Work with relations and investigate their properties. Investigate functions as relations and their properties. Introduce basic concepts of graphs, digraphs and trees.

**UNIT- I : The Foundations**

Logic and Proofs : Propositional - Applications of Propositional -Propositional Equivalences - Predicates and Quantifiers. (Chapter 1: Sections 1.1 - 1.3). Algorithms: The Growth of Functions. ( Chapter 3: Section 3.2).

**UNIT- II: Counting**

The Basics of Counting- The Pigeonhole Principle -Permutations and Combinations - Generalized Permutations and Combinations - Generating Permutations and Combinations . (Chapter 5: Sections 5.1- 5.3, 5.5 and 5.6).

**UNIT-III : Advanced Counting Techniques**

Applications ofRecurrence Relations - Solving Linear Recurrence Relations Generating Functions . (Chapter 6: Sections 6.1, 6.2 and 6.4).

**UNIT-IV : Boolean Algebra**

Boolean Functions- Representing Boolean Functions - Logic Gates - Minimization of Circuits. (Chapter 10: Sections 10.1 -10.4).

**UNIT-V: Modeling Computation** Finite-State machines with Output- Finite-State machines with No Output-Turing Machines. (Chapter 12: Sections 12.2, 12.3 and 12.5).

**Text Book:**

Kenneth H.Rosen, Discrete Mathematics and it‘s Applications,7thEdition, WCB / McGraw Hill Education ,New York,2008.

**Reference Books:**

1. J.P. Trembley and R.Manohar, Discrete Mathematical Structuresapplications to Computer Science, Tata McGraw Hills, New Delhi.
2. T.Veerarajan,Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw Hills Publishing Company Limited ,7thReprint,2008.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Verify the correctness of an argument using symbolic logic and truth tables.

**CLO 2:** Construct proofs using direct proof.

**CLO 3:** Proof by contradiction, and proof by cases, or mathematical induction.

**CLO 4:** Solve problems using counting techniques and combinatorics.

**CLO 5:** Determine properties of relations, identify equivalence and partial order relations.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-IV** | | **Course Code: 24PMA2C04** | **Course Title**: Advanced Algebra | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 5 | 100 |

## Course Objectives

To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.

**UNIT- I :**

Extension fields – Transcendence of e. Chapter 5: Section 5.1 and 5.2.

**UNIT- II:**

Roots or Polynomials.- More about roots. Chapter 5: Sections 5.3 and 5.5.

**UNIT-III :**

Elements of Galois theory. Chapter 5 : Section 5.6

**UNIT-IV :**

Finite fields - Wedderburn's theorem on finite division rings. Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only).

**UNIT-V:**

Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem. Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)
Chapter 7 : Sections 7.3 and 7.4

**Text Book:**

I.N. Herstein. *Topics in Algebra* (II Edition) Wiley EasternLimited, New Delhi, 1975.

**Reference Books:**

1. M.Artin, *Algebra,* Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)

3. I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II *Rings,*Narosa Publishing House , New Delhi, 1999
4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.
5. N.Jacobson, *Basic Algebra,* Vol. I & II Hindustan Publishing Company, New Delhi.

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org, www.algebra.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Prove theorems applying algebraic ways of thinking.

**CLO2:** Connect groups with graphs and understanding about Hamiltonian graphs.

**CLO3:** Compose clear and accurate proofs using the concepts of Galois Theory.

**CLO4:** Bring out insight into Abstract Algebra with focus on axiomatic theories.

**CLO5:** Demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-V** | **Course Code:24PMA2C05** | | **Course Title**: Real Analysis-II | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 5 | 100 |

## Course Objectives

To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.

### UNIT- I : Measure on the Real line

Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability. Chapter - 2 Sec 2.1 to 2.5 (de Barra).

### UNIT- II: Integration of Functions of a Real variable

Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals.

Chapter - 3 Sec 3.1,3.2 and 3.4 (de Barra).

### UNIT-III : Fourier Series and Fourier Integrals

Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem. Chapter 11 : Sections 11.1 to 11.15 (Apostol).

### UNIT-IV : Multivariable Differential Calculus

Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of $R^n$ to $R^1$. Chapter 12 : Section 12.1 to 12.14 (Apostol).

**UNIT-V: Implicit Functions and Extremum Problems**

Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions. Chapter 13 : Sections 13.1 to 13.7 (Apostol)**.**

**Text Books:**

1. G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II).
2. Tom M.Apostol : Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)

**Reference Books:**

1. Burkill,J.C.The Lebesgue Integral, Cambridge University Press, 1951.
2. Munroe,M.E.Measure and Integration. Addison-Wesley, Mass.1971.
3. Roydon,H.L.Real Analysis, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York,1979.
5. Malik,S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
6. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.

**CLO2:** Analyze the representation and convergence problems of Fourier series.

**CLO3:** Analyze and evaluate the difference between transforms of various functions.

**CLO4:** Formulate and evaluate complex contour integrals directly and by the fundamental theorem.

**CLO5:** Apply the Cauchy integral theorem in its various versions to compute contour integration.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-VI** | | **Course Code:24PMA2C06** | **Course Title**: Partial Differential Equations | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 4 | 100 |

## Course Objectives

To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.

**UNIT- I : Mathematical Models and Classification of second order equation**

Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – canonical forms – equations with constant coefficients – general solution. Chapter 2 : Sections 2.1 to 2.6, Chapter 3 : Sections 3.1 to 3.4 (Omit 3.5).

**UNIT- II: Cauchy Problem**

The Cauchy problem – Cauchy-Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation – cylindrical wave equation. Chapter 4 : Sections 4.1 to 4.11.

**UNIT-III : Method of separation of variables**

Separation of variable- Vibrating string problem – Existence and uniqueness of solution of vibrating string problem - Heat conduction problem – Existence and uniqueness of solution of heat conduction problem – Laplace and beam equations. Chapter 6 : Sections 6.1 to 6.6 (Omit section 6.7).

**UNIT-IV : Boundary Value Problems**

Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle , a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle. Chapter 8 : Sections 8.1 to 8.9.

**UNIT-V: Green's Function**

The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem. Chapter 10 : Section 10.1 to 10.9.

**Text Book:**

TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Fourth Edition), North Hollan, New York, 1987.

**Reference Books:**

1. M.M.Smirnov, *Second Order partial Differential Equations*, Leningrad, 1964.
2. I.N.Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, New Delhi, 1983.
3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw Hill, New York, 1968.
4. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd., New Delhi, 2001.
5. S, Sankar Rao, *Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2004.

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** To understand and classify second order equations and find general solutions

**CLO2:** To analyse and solve wave equations in different polar coordinates

**CLO3:** To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations

**CLO4:** To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions

**CLO5:** To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

**Semester II : Elective III and Elective IV**

**Elective III** to be chosen from Group C and **Elective IV** to be chosen from Group D

| **Program: M.Sc. Mathematics** | | | | |
|---|---|---|---|---|
| **Elective - III** | | **Course Code:24PMA2E09** | **Course Title**: Algebraic Topology | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

To introduce the ideas of algebraic topology to other branches of Mathematics

**UNIT I : Calculus In The Plane: Path Integrals**

Angles and Deformations - Differential forms and path Integrals - Independence of Path -Criterion for exactness. Angles and Deformations: Angle functions and Winding numbers - Reparametrizing and Deforming the Paths. Winding Numbers. Definition - Homotopy and Reparametrization - Varying the Point - Degrees and Local Degrees. Chapter 1 : (a) to (c); Chapter 2: only (a) and (b) Chapter 3 : (a) to (d)

**UNIT II: Cohomology And Homology**

De Rham Cohomology and the Jordan Curve Theorem. Definition of the De Rham Graphs - The Coboundary map - the Jordon Curve Theorem - Applications and Variations. Homology: Chains, Cycles, and H0U - Boundaries, H1U , and Winding Numbers - Chains on Grids - Maps and Homology - The First Homology Group for General Spaces. Chapter 5: (a) to (d) Chapter 6: (a) to (e).

**UNIT-III : Holes And Integrals**

Multiply connected regions - Integrations over continuous Paths and Chains - Periods of Integrals - Complex Integration Mayer-Victoris: The Boundary map - Mayer-Victoris for Homology - Variations and applications - Mayer-Victoris for Cohomology. Chapter 9: (a) to (d) Chapter 10: (a) to (d).

**UNIT-IV : Covering Spaces And Fundamental Groups**

Covering Spaces: Definition - Lifting paths and Homotopies - G-coverings - Covering Transformations. The Fundamental Groups: Definitions and Basic Properties - Homotopy - Fundamental Group and Homology. Fundamental Groups and Covering Spaces: Fundamental Group and Coverings - Automorphisms of Coverings - The Universal Covering - Coverings and Subgroups of the Fundamental Group Chapter 11 : (a) to (d) Chapter 12 : (a) to (c) Chapter 13: (a) to (d)

**UNIT-V: The Van Kampen Theorem** G-Coverings from the Universal Covering - Patching Coverings together - The Van Kampen Theorem Cohomology: Patching Coverings and Cech cohomology - Cech Cohomology and Homology - De Rham Cohomology and Homology - Proof of Mayer -Victoris for De Rham Cohomology. Chapter 14 : (a) to (d) ; Chapter 15: (a) to (d)

**Text Book:**

William Fulton, Algebraic Topology – A First Course, Springer-Verlag, NewYork, 1995.

**Reference Books:**

1. M.K.Agoston, Algebraic topology- A First Course, Marcel Dekker, 1962
2. Satya Deo, Algebraic Topology, Hindustan Book Agency, New Delhi,2003.
3. M.Greenberg and Harper, Algebraic Topology-A First course,Benjamin/Cummings, 1981.
4. C.F. Maunder, Algebraic topology, Van Nastrand, New York, 1970 5. J.R. Mukres, Topology, Prentica Hall of India, New Delhi, 2002 (3rd Indian Print).

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Demonstrate accurate and efficient use of algebraic topology techniques.
**CLO2:** Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from algebraic topology.
**CLO3:** Apply problem-solving using algebraic topology techniques applied to diverse situations in physics, engineering and other mathematical contexts
**CLO4:** Explain the fundamental concepts of algebraic topology and their role in modern mathematics and applied contexts.
**CLO5:** Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective - III** | **Course Code:24PMA2E10** | | **Course Title**: Mathematical statistics | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

Calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables. Upon successful completion of this course , students will be able to: Use discrete and continuous probability distributions, including requirements, mean and variance, and making decisions

**UNIT- I : Probability and Random Variables**

Probability – Axioms – Combinatorics, Probability on finite sample spaces – Conditional probability and Baye‘s theorem - Independence of events – Random variables – Probability distribution of a random variable – Discrete and continuous random variables – Function of a random variable. (Chapter 1: Sections 1.3 to 1.6 and Chapter 2: Sections 2.2 to 2.5)

**UNIT- II: Moments and Generating Functions**

Moments of a distribution function – Generating functions – Some moment inequalities. (Chapter 3: Sections 3.2 to 3.4)

**UNIT-III : Multiple Random Variables**

Multiple random variables – Independent random variables – Functions of several random variables.(Chapter 4: Sections 4.2 to 4.4)

**UNIT-IV : Multiple Random Variables (Contd.)**

Covariance, Correlation and moments – Conditional expectation – Some discrete distributions – Some continuous distributions. (Chapter 4: Sections 4.5 and 4.6 and Chapter 5: Sections 5.2 to 5.3)

**UNIT-V: Limit Theorems**

Modes of convergence – Weak law of large numbers – Strong law of large numbers – Central limit theorems.(Chapter 6: Sections 6.2 to 6.4 and 6.6)

**Text Book:**

V.K. Rohatgi and Statistics, John Wiley Pvt, Singapore, 2001.

**Reference Books:**

1. G.G. Roussas, A First Course in Mathematical Statistics, AdditionWesley Publ. Co. Mass, 1973.
2. M. Fisz, Probability Theory and Mathematical Statistics, John Wiley,New York, 1963.
3. E.J. Dudewisg and S.N. Mishra, Modern Mathematical Statistics,John Wiley, New York, 1988.

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events.

**CLO2:** Translate real-world problems into probability models.

**CLO3:** Derive the probability density function of transformation of random variables.

**CLO4:** Calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables.

**CLO5:** Analyze statistical using Multiple Random Variables.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-III** | **Course Code: 24PMA2E11** | | **Course Title**: Statistical Data Analysis Using R- Programming | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

Introduce basic statistics for exploratory data analysis including methods for describing and summarizing variable distributions. Provide essential skills for data manipulation including selecting subsets and recoding. Introduce the visual representation of variables in scatter graphs, bar charts, and histograms.

**UNIT- I : Introduction to R programming**

What is R? - Installing R and R Studio – R Studio Overview - Working in the Console - Arithmetic Operators – Logical Operations - Using Functions - Getting Help in R and Quitting R Studio- Installing and loading packages. Data structures, variables, and data types in R: Creating Variables - Numeric, Character and Logical Data - Vectors - Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors - Special Values.

**UNIT- II: Data Visualization using R**

Scatter Plots - Box Plots - ScatterPlots and Box- and-Whisker Plots Together -Customize plot axes, labels,add legends, and add colours.

**UNIT-III : Descriptive statistics in R**

Measures of central tendency -Measures of variability - Skewness and kurtosis - Summary functions, describe functions, and descriptive statistics by group.

**UNIT-IV : Testing of Hypothesis using R**

T-test, Paired Test, correlation, Chi Square test, Analysis of Variance and Correlation.

**UNIT-V: Predictive Analytics**

linear Regression model, Non-LinearLeast Square, multiple regression analysis, Logistic Regression, Panel Regression Analysis, ARCH Model, GARCH models, VIF model.

**Text Books:**

1. Crawley, M.J.(2006) " Statistics An introduction using R", John wiley, London 32.
2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), ―Statistics using R‖,second edition. Narosa Publishing House, New Delhi.

3. Shahababa B. (2011) , –Biostatistics with R‖, Springer, New York.
4. Braun & Murdoch (2007), —A first course in statistical programming withR‖, Cambridge University Press, New Delhi.

**Website and e-Learning Source**

1. https://cran.r-project.org/doc/contrib/Owen-TheRGuide.pdf
2. https://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/R/R-Manual/R-Manual2.html
3. https://smac-group.github.io/ds/
4. https://www.geeksforgeeks.org/predictive-analysis-in-r

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Explain critical R programming concepts.

**CLO2:** Demonstrate how to install and configure RStudio.

**CLO3:** Explain the use of data structure and loop functions.

**CLO4:** Analyse data and generate reports based on the data.

.**CLO5:** Apply various concepts to write programs in R.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective - III** | **Course Code: 24PMA2E12** | | **Course Title**:Tensor Analysis And Relativity Theory | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits:** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

The course aims to introduce vector algebra and vector calculus and special relativity and relativistic kinematics, dynamics and accelerated systems.

### UNIT- I : Tensor Algebra

Systems of Different orders - Summation Convention - Kronecker Symbols - Transformation of coordinates in Sn - Invariants - Covariant and Contravariant vectors - Tensors of Second Order - Mixed Tensors - Zero Tensor - Tensor Field. Algebra of Tensors - Equality of Tensors - Symmetric and Skew – symmetric tensors - Outer multiplication, Contraction and Inner Multiplication - Quotient Law of Tensors - Reciprocal Tensor of Tensor Relative Tensor - Cross Product of Vectors. Chapter I : I.1 - I.3, I.7 and I.8 and Chapter II : II.1 - II.19.

### UNIT- II: Tensor Calculus

Riemannian Space - ChristoffelSymbols and their properties, Chapter III: III.1 and III.2

### UNIT-III : Tensor Calculus (Contd.)

Covariant Differentiation of Tensors - Riemann - Christoffel Curvature Tensor - Intrinsic Differentiation. Chapter III: III.3 - III.5

### UNIT-IV : Special Theory Of Relativity

Galilean Transformation - Maxwell‘s equations - The ether Theory - The Principle of Relativity. Relativistic Kinematics : Lorentz Transformation equations - Events and simultaneity - Example - Einstein Train - Time dilation - Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example - twin paradox - addition of velocities- Relativistic Doppler effect. Chapter 7 : Sections 7.1 and 7.2

### UNIT-V: Relativistic Dynamics

Momentum - Energy - Momentum - energy four vector - Force - Conservation of Energy - Mass and energy - Example - inelastic collision - Principle of equivalence - Lagrangian and Hamiltonian formulations. Accelerated Systems : Rocket with constant acceleration - example - Rocket with constant thrust . Chapter 7 : Sections 7.3 and 7.4

**Text Books:**

1.U.C. De, Absos Ali Shaikh and Joydeep Sengupta, Tensor Calculus,Narosa Publishing House, New Delhi, 2004.

2. D. Greenwood, Classical Dynamics, Prentice Hall of India, NewDelhi, 1985.

**Reference Books:**

1. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949.
2. A.S.Eddington. The Mathematical Theory of Relativity, CambridgeUniversity Press, 1930.
3. P.G.Bergman, An Introduction to Theory of Relativity, New York,1942
4. C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus,Cambridge, 1938.

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** The Relations between other papers of Mathematics.

**CLO2:** To Study and to learn the cause effect related to these.

**CLO3:** Visualization of the transformation of the mathematical quanitities from one space to other and their expressions.

**CLO4:** The applications in observing and relating real situations/Structures.

.**CLO5:** The use of tensor fields allows us to present physical laws in a clear, compact form.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective - IV** | **Course Code:24PMA2E13** | | **Course Title**: Wavelets | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

To establish the theory necessary to understand and use wavelets and related constructions.

**UNIT-I: Signals and Systems**

Basic concepts of signals and systems, Frequency spectrum of signals; Classification of signals: Discrete time signals and continuous time signals, periodic and non-periodic signals; Classification of systems: Linear, nonlinear, time-variant, time-invariant, stable and unstable systems.

**UNIT-II:: Haar Scaling Function and Wavelet**

Time-Frequency Analysis Orthogonal functions, Orthonormal functions, Function spaces, Orthogonal basis functions, Haar scaling function, Haar spaces: Haar space, general Haar space $V$□; Haar wavelet, Haar wavelet spaces: Haar wavelet space general Haar wavelet space ; Decomposition and reconstruction, Time-frequency analysis.

**UNIT-III:Fourier Transforms and Wavelets**

Orthogonal and orthonormal bases Discrete Fourier transform of a digital signal, Complex form of a Fourier series, Inverse discrete Fourier transform, Window Fourier transform, short time Fourier transform, Admissibility condition for a wavelet, Classes of wavelets: Haar, Morlet, Maxican hat, Meyer and Daubechies wavelets; Wavelets with compact support.

**UNIT-IV:Discrete Wavelet Transforms**

Stationary and non-stationary signals, Haar transform, 1-level Haar transform, Multi-level Haar Stationary and non-stationary signals, Haar transform, Conservation and compaction of energy, Multiresolution analysis, Decomposition and reconstruction of signals using discrete wavelet transform (DWT).

**UNIT-V:Applications**

Wavelet series expansion using Haar and other wavelets, Applications in signal compression, Analysis and classification of audio signals using DWT, Signal de-noising: Image and ECG signals

**Text Book:**

Charles K. Chui, An Introduction to Wavelets. Academic Press, 1992.

**Reference Books:**

1. Ingrid Daubechies, Ten Lectures on Wavelets. SIAM, 1999.
2. Michael W. Frazier, An Introduction to Wavelets Through LinearAlgebra. Springer-Verlag, 1999.
3. Stéphane Mallat, A Wavelet Tour of Signal Processing (3rd edition).Academic Press, 2008.
4. M.J. Roberts, Signals and Systems: Analysis Using TransformMethods and MATLAB. McGraw-Hill Education, 2004
5. David K. Ruch & Patrick J. Van Fleet, Wavelet Theory: An Elementary Approach with Applications. John Wiley & Sons, 2009
6. James S. Walker, A Primer on Wavelets and Their Scientific Applications (2nd edition). Chapman & Hall/CRC, Taylor & Francis, 2008.

**Website and e-Learning Source**

1. https://archive.nptel.ac.in/courses/108/101/108101093/
2. https://onlinecourses.nptel.ac.in/noc23_ee32/preview

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Know basic concepts of signals and systems.

**CLO 2:** Understand the concept of Haar spaces.

**CLO 3:** Learn Fourier transform and wavelet transform of digital signals.

**CLO 4:** Learn applications of wavelets to the real-world problems.

**CLO 5:**Apply wavelets in signal processing and image processing.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 2 | 2 | 3 | 2 | 3 | 3 | 2 |
| CLO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| CLO3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CLO4 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| CLO5 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective - IV** | | **Course Code:24PMA2E14** | **Course Title**: Modeling And Simulation With Excel | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

The aim of the course is to elevate Excel models, to improve clarity, longevity, and transferability of these models, and to reduce mistakes and to encourage consistency in businesses as they work with Excel.

**UNIT-I:** Introduction- How Do We Classify Models? - An Example of Deterministic Modeling - Understanding the Important Elements of a Model.

**UNIT-II:** Model Building with Excel - Basic Model - Sensitivity Analysis -Controls from the Forms Control Tools- Scroll Bars .

**UNIT-III: Modeling and Simulation:** Types of Simulation and Uncertainty -Incorporating Uncertain Processes in Models -The Monte Carlo Sampling Methodology-Implementing Monte Carlo Simulation Methods-A Word About Probability Distributions -Modeling Arrivals with the Poisson Distribution-VLOOKUP and HLOOKUP Functions.

**UNIT-IV:** A Financial Example—Income Statement -An Operations Example—Autohaus -Status of Autohaus Model -Building the Brain Worksheet - Building the Calculation Worksheet-Variation in Approaches to Poisson Arrivals—Consideration of Modeling Accuracy.

**UNIT-V:** Sufficient Sample Size - Building the Data Collection Worksheet -Solver—Constrained Optimization -Example—York RiverArchaeology Budgeting –Scenarios.

**Text Book:**

Hector Guerrero , Excel Data Analysis Modeling and Simulation, Springer Heidelberg Dordrecht London New York.

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Describe the role of important elements of discrete event simulation and modeling paradigm.

**CLO 2:** Conceptualize real world situations related to systems development decisions, originating From source requirements and goals.

**CLO 3:** Develop skills to apply simulation software to construct and execute goal-driven system models.

**CLO 4:** Interpret the model and apply the results to resolve critical issues in a real world environment.

**CLO 5:** Learn applications of Simulation to the problems.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 2 | 2 | 3 | 2 | 3 | 3 | 2 |
| CLO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| CLO3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CLO4 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| CLO5 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-IV** | **Course Code:24PMA2E15** | | **Course Title**: Machine Learning and Artifical Intelligence | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits:** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

- To Learn about Machine Intelligence and Machine Learning applications
- To implement and apply machine learning algorithms to real- world applications.
- To identify and apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems.
- To understand how to perform evaluation of learning algorithms and model selection.
- To understand about the basic theory of problem solving paradigms and search strategies in artificial intelligence.
- To make the students familiar with knowledge representation, planning, learning, natural language processing and robotics

**UNIT-I: INTRODUCTION:**

Learning Problems – Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning –Representation – Algorithm – Heuristic Space Search.

**UNIT-II: NEURAL NETWORKS AND GENETIC ALGORITHMS:**

Neural Network Representation – Problems –Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms– Hypothesis Space Search – Genetic programming –Models of Evaluation and Learning.

**UNIT-III: BAYESIAN AND COMPUTATIONAL LEARNING:**

Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier –Bayesian Belief Network –EM Algorithm – Probability Learning – Sample Complexity –Finite and Infinite Hypothesis Spaces – Mistake Bound Model.

**UNIT-IV:** Introduction - Intelligent Agents- Problem Solving - by Searching - Informed Search Strategies-Optimization Problems - Adversarial Search-Knowledge and Reasoning - Logical Agents - First-Order Logic - Inference in First-Order Logic - Knowledge Representation.

**UNIT-V:** Planning – Planning and Acting in the Real World - Uncertain knowledge and reasoning - Uncertainty - Probabilistic Reasoning - Probabilistic Reasoning over Time - Making Simple Decisions - Making Complex Decisions.

**Text Books:**

1. Tom M. Mitchell,―Machine Learning, McGraw-Hill Education(India) Private Limited, 2013.
2. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach," Third Edition, Prentice Hall of India, New Delhi, 2010.

**Reference Books:**

1. Ethem Alpaydin,―Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
2. Stephen Marsland,―Machine Learning: An Algorithmic Perspective, CRC Press,2009.
3. Michael Affenzeller, Stephan Winkler, Stefan Wagner, AndreasBeham, –Genetic Algorithms and Genetic Programming‖,CRC Press Taylor and Francis Group.
4. Elaine Rich, Kevin Knight, B. Nair, "Artificial Intelligence," Third Edition, Tata McGraw-Hill, New Delhi, 2017.
5. Eugene Charniak, Drew McDermott, "Introduction to Artificial Intelligence," Pearson, 2002.

**Website and e-Learning Source**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.

**CLO 2:** Have an understanding of the strengths and weaknesses of many popular machine learning approaches.

**CLO 3:** Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and unsupervised learning.

**CLO 4:** Be able to design and implement various machine learning algorithms in a range of real-world applications.

**CLO 5:** Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 2 | 2 | 3 | 2 | 3 | 3 | 2 |
| CLO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| CLO3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CLO4 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| CLO5 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-IV** | **Course Code:24PMA2E16** | | **Course Title**: Neural Networks | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits:** | **Total Marks** |
| II | 6 | 90 | 3 | 100 |

## Course Objectives

Enable students to understand important concepts and theories ofartificial neural networks (ANNs), Enable students to understand how ANNs can be designed and trained Enable students to calculate simple examples of ANNs.

**UNIT-I:** Introductory Concepts:'Neurons' and their basic function- Math review- Mathematical Machinery and Review- How and Why Perceptron's Can Compute Logic Statements- Training Perceptron's Using Supervised Learning Techniques- Training Multi-layer.

**UNIT-II:** Neural Networks Using Supervised Learning Techniques: RecurrentNeural Networks and Unsupervised Learning: Optimization Techniques- Implementation and Performance Considerations-Variations on the Hopfield Network-A Stochastic Version of the Hopfield Network:

**UNIT-III:** The Boltzmann Machine-A Stochastic Version of the Binary Associative Memory: Restricted Boltzmann Machines-Competitive Learningand Self-Organizing Maps-Neural Network Modifications and Applications- Cellular Neural Networks and the Future of Massively Parallel Computation.

**UNIT-IV:** Introduction to Machine Learning Techniques: Types of learning,hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, overfitting.

**UNIT-V:** Support Vector Machine, Kernel function and Kernel SVM. Neuralnetwork: Perceptron, multilayer network, backpropagation, introduction to deep neural network.

**Text Books:**

1. Raul Rojas, Neural Networks - A Systematic Introduction, Springer-Verlag, Berlin, NewYork,1996.
2. Koch, Christof, Biophysics of Computation: Information Processing in Single Neurons, Oxford University Press, 2004.

**Reference Books:**

1. G. Dreyfus, Neural Networks Methodology and Applications,Springer, Berlin, Heidelberg, 2004.
2. James A. Freeman David M. Skapura, Neural Networks Algorithms,Applications, and Programming Techniques, Addison-Wesley Publishing Company, New York, 1991.

**Website and e-Learning Source:**

1. https://nptel.ac.in/courses/117105084
2. https://www.digimat.in/nptel/courses/video/127105006/L01.html
3. https://www.youtube.com/watch?v=NeMAxhDvSak&list=PLgMDNELGJ1CZn1399dV7_U4VBNJflRsua
4. https://www.youtube.com/watch?v=QlhHqMnd9Wo

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Learn different types of neural networks and different types of learning models

**CLO 2:** Determine the mathematical foundations of neural network models

**CLO 3:**Implement of neural networks using training algorithms such as the feed-forward, back-propagation algorithm

**CLO 4:** Design neural networks for practical purposes

**CLO 5:**Build neural networks for practical purposes

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CLO2 | 2 | 1 | 2 | 1 | 3 | 2 | 3 | 3 | 3 |
| CLO3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CLO4 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| CLO5 | 3 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 2 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core - VII** | **Course Code:24PMA3C07** | | **Course Title**: Complex Analysis | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits:** | **Total Marks** |
| III | 6 | 90 | **5** | 100 |

## Course Objectives

To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integral and harmonic functions

**UNIT-I: Cauchy's Integral Formula:** The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions Removable Singularities-Taylors's Theorem – Zeros and poles – The local Mapping – The Maximum Principle. Chapter 4 : Section 2 : 2.1 to 2.3, Chapter 4 : Section 3 : 3.1 to 3.4.

**UNIT-II: The general form of Cauchy's Theorem :** Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials- Multiply connected regions - Residue theorem - The argument principle. Chapter 4 : Section 4 : 4.1 to 4.7, Chapter 4 : Section 5: 5.1 and 5.2

**UNIT-III: Evaluation of Definite Integrals and Harmonic Functions** Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula. Chapter 4 : Section 5 : 5.3, Chapter 4 : Sections 6 : 6.1 to 6.3.

**UNIT-IV: Harmonic Functions and Power Series Expansions:**
Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor's Series – Laurent series. Chapter 4 : Sections 6.4 and 6.5, Chapter 5 : Sections 1.1 to 1.3.

**UNIT-V: Partial Fractions and Entire Functions:** Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem.
Chapter 5 : Sections 2.1 to 2.4, Chapter 5 : Sections 3.1 and 3.2.

**Text Book:**

Lars V. Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., New York, 1979.

**Reference Books:**

1. H.A. Presfly, *Introduction to complex Analysis*, Clarendon Press, oxford, 1990.
2. J.B. Conway, *Functions of one complex variables* Springer - Verlag, International student Edition, Naroser Publishing Co.1978
3. E. Hille, *Analytic function Thorey* (2 vols.), Gonm& Co, 1959.
4. M.Heins, *Complex function Theory*, Academic Press, New York,1968.

**Website and e-Learning Source:**

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org , http://en.wikipedia.org.

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Analyze and evaluate local properties of analytical functions and definite integrals.

**CLO2:** Describe the concept of definite integral and harmonic functions.

**CLO3:** Demonstrate the concept of the general form of Cauchy's theorem

**CLO4**: Develop Taylor and Laurent series .

**CLO5** Explain the infinite products, canonical products and jensen's formula .

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core - VIII** | **Course Code:24PMA3C08** | | **Course Title**: Probability Theory | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits:** | **Total Marks** |
| III | 6 | 90 | **5** | 100 |

## Course Objectives

To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.

**UNIT-I : Random Events and Random Variables:** Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables.
Chapter 1: Sections 1.1 to 1.7, Chapter 2 : Sections 2.1 to 2.9.

**UNIT-II : Parameters of the Distribution :** Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types. Chapter 3 : Sections 3.1 to 3.8.

**UNIT-III: Characteristic functions :** Properties of characteristic functions – Characteristic functions and moments – semi0invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions.

**UNIT-IV : Some Probability distributions:** One point , two point , Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions. Chapter 5 : Section 5.1 to 5.10 (Omit Section 5.11).

**UNIT-V: Limit Theorems :** Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers. Chapter 6 : Sections 6.1 to 6.4, 6.6 to 6.9 , 6.11 and 6.12. (Omit Sections 6.5, 6.10,6.13 to 6.15).

**Text Book:**

M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.

**Reference Books:**

1. R.B. Ash, *Real Analysis and Probability*, Academic Press, New York, 1972.

2. K.L.Chung, *A course in Probability*, Academic Press, New York, 1974.

4. R.Durrett, *Probability : Theory and Examples*, (2nd Edition) Duxbury Press, New York, 1996.

5. V.K.Rohatgi*An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).

6. S.I.Resnick, *A Probability Path*, Birhauser, Berlin,1999.

7. B.R.Bhat , *Modern Probability Theory* (3rd Edition), New Age International (P)Ltd, New Delhi, 1999.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, http://www.probability.net

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** To define Random Events, Random Variables, to describe Probability, to apply Bayes, to define Distribution Function, to find Joint Distribution function, to find Marginal Distribution and Conditional Distribution function, to solve functions on random variables.

**CLO2:** To define Expectation, Moments and Chebyshev Inequality, to solve Regression of the first and second types.

**CLO3:** To define Characteristic functions, to define distribution function, to find probability generating functions, to solve problems applying characteristic functions

**CLO4:** To define One point, two-point, Binomial distributions, to solve problems of Hypergeometric and Poisson distributions, to define Uniform, normal, gamma, Beta distributions, to solve problems on Cauchy and Laplace distributions

**CLO5:** To discuss Stochastic convergence, Bernaulli law of large numbers, to elaborate Convergence of sequence of distribution functions, to prove Levy-Cramer Theorems and de Moivre-Laplace Theorems, to explain Poisson, Chebyshev, Khintchine Weak law of large numbers, to explain and solve problems on Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core - IX** | **Course Code:24PMA3C09** | | **Course Title**: Topology | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| III | 6 | 90 | 5 | 100 |

## Course Objectives

To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.

**UNIT-I : Topological spaces :** Topological spaces – Basis for a topology – The order topology – The product topology on X × Y – The subspace topology – Closed sets and limit points. Chapter 2 : Sections 12 to 17.

**UNIT-II :Continuous functions:** Continuous functions – the product topology – The metric topology. Chapter 2 : Sections 18 to 21 (Omit Section 22).

**UNIT-III :Connectedness:** Connected spaces- connected subspaces of the Real line – Components and local connectedness. Chapter 3 : Sections 23 to 25.

**UNIT-IV : Compactness :** Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness. Chapter 3 : Sections 26 to 29.

**UNIT-V:** Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietz extension theorem. Chapter 4 : Sections 30 to 35.

**Text Book:**

James R. Munkres, *Topology* (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint).

**Reference Books:**

1. J. Dugundji ,*Topology* , Prentice Hall of India, New Delhi, 1975.
2. George F.Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963
3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York
4. L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
5. S.Willard, *General Topology*, Addison - Wesley, Mass., 1970.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org , http://en.wikipedia.org

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Define and illustrate the concept of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space. **CLO2**: Understand continuity, compactness, connectedness, homeomorphism and topological properties.

**CLO3**: Analyze and apply the topological concepts in Functional Analysis.

**CLO4:** Ability to determine that a given point in a topological space is either a limit point or not for a given subset of a topological space.

**CLO5**: Develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff and develop tools to identify when two are equivalent(homeomorphic).

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

**Title of the Course: CORE INDUSTRY MODULES**
**(Choose from out Side of the Department)**

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core - X** | | **Course Code: 24PMA3C10** | **Course Title**: Machine Learning [Advancements in industry 4.0] | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| III | 6 | 90 | 4 | 100 |

## Course Objectives

The ultimate goal of Industrial Machine Learning is to create a more agile and flexible manufacturing process that can respond quickly to changing market demands while improving efficiency, quality, and sustainability.

**UNIT-I : Machine Learning**

Machine Learning : Introduction -Definition –Types of Machine Learning -Supervised, Unsupervised, Reinforcement LearningAlgorithms for Machine Learning – problems solved by Machine Learning – Tools for Machine Learning – Applications.

**UNIT-II : Robotic Process Automation(RPA)**

Robotic Process Automation(RPA):Introduction to RPA –Need for automation programming constructs in RPA- Robots and Softbots – RPA architecture and process methodologies –Industries best suited for RPA.

**UNIT-III: Cloud:** Cloud Computing: Need-Definition –Types of Cloud -Types of services –Saas.

**UNIT-IV: Cyber:** Cyber Security: Cyber Crime and Information security – Classification of cyber Crime Types.

**UNIT-V: VIRTUAL**

Virtual Reality: Definition- Types of Head Mounted Displays -Tools for Reality

**Text Book:**

1. Higher Education for industry 4.0 and Transformation to Education 5.0 by P. Kaliraj and T.Devi

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org, http://en.wikipedia.org.

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Comprehend Business model innovation through Industrial Machine Learning.

**CLO2**: Comprehend IoT, cyber-physical systems, cloud computing and big data, smart factories and their role in Industrial Machine Learning.

**CLO3**: Understand drivers and enablers of Industrial Machine Learning, including policy support.

**CLO4:** Understand the nature of the fourth industrial revolution and theoretical concepts..

**CLO5**: Understand the opportunities, and challenges brought through Industrial Machine Learning.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

**Elective V** to be chosen from **Group E:**

| **Program: M.Sc. Mathematics** | | | | |
|---|---|---|---|---|
| **Elective – V (From Group – E)** | **Course Code:24PMA3E17** | | **Course Title:** Algebraic Number Theory | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| III | 6 | 90 | 3 | 100 |

**Course Objectives**

The course aims to provide a study on modules over rings, finite fields, algebraic extensions, number fields and cyclotomic fields, Noetherian rings and modules and Dedekind rings.

**UNIT-I: Algebraic Background**

Rings and Fields- Factorization of Polynomials - Field Extensions - Symmetric Polynomials - Modules - Free Abelian Groups.Chapter 1: Sec. 1.1 to 1.6

**UNIT-II: Algebraic Numbers**

Algebraic numbers - Conjugates and Discriminants - Algebraic Integers - Integral Bases - Norms and Traces - Rings of Integers. Chapters 2: Sec. 2.1 to 2.6

**UNIT-III: Quadratic And Cyclotomic Fields**

Quadratic fields and cyclotomatic fields : Factorization into Irreducibles : Trivial factorization - Factroization into irreducibles - Examples of non-uniquefactorization into irreducibles.
Chapter 3: Sec. 3.1 and 3.2 ; Chapter 4: Sec. 4.2 to 4.4

**UNIT-IV: Prime Factroization**

Euclidean Domains - Euclidean Quadratic fields - Consequences of unique factorization - The Ramanujan -Nagell Theorem. Chapter 4: Sec. 4.5 to 4.9.

**UNIT-V: Ideals**

Prime Factorization of Ideals - The norms of an Ideal - Non-unique Factorization in Cyclotomic Fields. Chapter 5 : Sec. 5.2 to 5.4

**Text Book:**

I.Steward and D.Tall. Algebraic Number Theory and Fermat's Last Theorem (3rd Edition) A.K.Peters Ltd., Natrick, Mass. 2002.

**Reference Books:**

1. Z.I.Bosevic and I.R.Safarevic, Number Theory, Academic Press, New York, 1966.
2. J.W.S.Cassels and A.Frohlich, Algebraic Number Theory, Academic Press, New York, 1967.
3. P.Ribenboim, Algebraic Numbers, Wiley, New York, 1972.
4. P. Samuel, Algebraic Theory of Numbers, Houghton Mifflin Company, Boston, 1970.
5. A.Weil. Basic Number Theory, Springer, New York, 1967.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** The concept (definition and significance) of algebraic numbers and algebraic integers.

**CLO2:** How to factorise an algebraic integer into irreducibles.

**CLO3:** How to find the ideals of an algebraic number ring.

**CLO4**: The definition of the Class Group.

**CLO5:** The definition of anIdeals.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective – V (From Group – E)** | | **Course Code: 24PMA3E18** | | **Course Title:** Fluid Dynamics |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| III | 6 | 90 | 3 | 100 |

## Course Objectives

Understand the various properties of fluids and their influence on fluid motion and analyse a variety of problems in fluid statics and dynamics. Calculate the forces that act on submerged planes and curves.

**UNIT- I : Kinematics of Fluids in Motion**

Real fluids and Ideal fluids - Velocity of a fluid at a point –Stream lines and path lines - Steady and Unsteady flows - The Velocity Potential - The Vorticity Vector - Local and Particle Rates of Change - The Equation of Continuity - Worked Examples. (Chapter 2: Sections 2.1 - 2.8).

**UNIT- II: Equations of Motion of a Fluid**

Pressure at a point in a fluid at rest - Pressure at a point in a moving fluid - Euler's equationsof Motion - Bernoulli's equation -Worked Examples - Discussion ofthe case of steady motion under Conservative Body Forces - Some flows involving axial symmetry(examples 1 and 2 only). (Chapters 3: Sections 3.1, 3.2,3.4 - 3.7, 3.9).

**UNIT-III: Some Three-Dimensional Flows**

Introduction - Sources, Sinks and Doublets-Images in rigid infinite plane - Images in solid spheres – Axis symmetric flows. (Chapter 4: Sections 4.1 - 4.4).

**UNIT-IV: Some Two-Dimensional Flows**

The Stream Function - The Complex Velocity Potential for Two Dimensional Irrotational, Incompressible Flow - Complex Velocity Potentials for Standard TwoDimensional Flows - Some Worked Examples - Two Dimensional Image Systems - The Milne-Thomson Circle Theorem. (Chapter 5: Sections 5.3 - 5.8).

**UNIT-V: Viscous Fluid**

Stress components in a real fluid - Relation between Cartesian Components of Stress - Translational motion of fluid element – The Coefficient of Viscosity and Laminar flow - The Navier- Stokes equation of a viscous fluid - Some solvable problems in viscous flow – Steady motion between parallel planes only. (Chapter 8:Sections 8.1 - 8.3, 8.8, 8.9 and 8.10.1).

**Text Book:**

Frank Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, 2004.

**Reference Books:**

1. L.M. Milne-Thomson, Theoretical Hydrodynamics, Macmillan,London, 1955.

2.G.K. Batchelor, An Introduction to Fluid Dynamics CambridgeMathematical Library, 2000.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com.

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Calculate the forces that act on submerged planes and curves.

**CLO2:** Identify and analyse various types of fluid flows.

**CLO3:** Apply the integral forms of the three fundamental laws of fluid mechanics.

**CLO4**: Turbulent and laminar flow through pipes.

**CLO5:** Ducts in order to predict relevant pressures, velocities and forces.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective – V (From Group – E)** | | **Course Code:24PMA3E19** | **Course Title:** Stochastic Processes | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| III | 6 | 90 | 3 | 100 |

## Course Objectives

Carry out derivations involving conditional probability distributions and conditional expectations. Define basic concepts from the theory of Markov chains and present proofs for the most important theorems.

**UNIT- I :**

Introduction to stochastic process (SP) – classification of SP according to state space and time domain. countable state markov chain (MC). Chapman- Kolmogorov equations. Calculation of 'n' step transition probability.

**UNIT- II:**

Discrete state space – continuous time MC. Kolmogorov differential. Poisson process, birth and death process. Application to equations queues and storage problem. Random walk.

**UNIT-III:**

Markov process – continuous time and continuous state space - time homogenous markov process – Kolmogorov's equation. Wiener process as a limit of random walk, first passage time Diffusion process with Wiener process.

**UNIT-IV:**

Stationary process and time series- wide sense and strict sense stationary process – moving average and auto regressive process. Covariance function - Bochner's function (statement), Khintchine's representation of wide sense stationary process.

**UNIT-V:**

Renewal theory – renewal function and its properties –Elementary and key renewal theorems.

**Text Books:**

1. Medhi.J. (1982) Stochastic process, Wiley Eastern.
2. Basu. A.K. (2003) Introduction to stochastic processes, NewsaPublishing House.

**Reference Books:**

1. Ross. S.M. (1983) Stochastic Process, Wiley, New York.
2. Karlin and First course in Stochastic Process-Vol.I&II, AcademicPress. Taylor.H.M. (1975)

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Apply the fundamentals of probability theory and random processes to practical engineering problems.

**CLO2:** Identify and interpret the key parameters that underlie the random nature of the problems.

**CLO3:** Use the top-down approach to translate engineering system requirements into practical design problems.

**CLO4**: Compute probabilities of transition between states and return to the initial state after long time intervals in Markov chains.

**CLO5:** Identify classes of states in Markov chains and characterize the classes. Determine limit probabilities in Markov chains after an infinitely long period.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective – V (From Group – E)** | | **Course Code:24PMA3E20** | **Course Title:** Mathematical Python | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| III | 6 | 90 | 3 | 100 |

## Course objectives

This course aims

- To introduce to students Python programming.
- To learn python coding to implement algorithms for Mathematical problems.

**UNIT- I : Introduction to Python**

Basic syntax, variable types, basic operators, numbers, strings, lists, tuples, functions and input/outputstatements. Some simple programs to understand the relational, conditional and logical operators. Compare two numbers (less than, greater than) using if statement. Sum of natural numbers using while loop; Finding the factors of a number using for loop; To check the given number is prime or not (use if... else statement); Find the factorial of a number (use if...if...else).; Simple programs to illustrate logical operators (and, or, not).

**UNIT- II: Matrices, Differential Calculus & Analytical Geometry of Three Dimensions**

Python commands to reduce given matrix to echelon form and normal form with examples. Python program/command to establish the consistency or otherwise and solving system of linear equations. Python command to find the nth derivatives. Python program to find nth derivative with and without Leibnitz rule. Obtaining partial derivative of some standard functions Verification of Euler‘s theorem, its extension and Jacobean. Python program for reduction formula with or without limits. Python program to find equation and plot sphere, cone, cylinder.

**UNIT-III: Roots of High-Degree Equations- Systems of Linear Equations**

Introduction, Simple Iterations Method - Finite Differences Method, Gauss Elimination Method: Algorithm, Gauss Elimination Method, Jacobi's Method, Gauss-Seidel's Method.

**UNIT-IV: Numerical differentiation, Integration and Ordinary Differential Equations**

Introduction & Euler's Method, Second Order Runge-Kutta's Method, Fourth Order Runge-Kutta's Method, Fourth Order Runge-Kutta's Method: Plot Numerical and Exact Solutions.

**UNIT-V: Two-Point Boundary Value Problems Introduction to two- point boundary value Problems:**

second order differential equations -Higher order differential equations - solution of second order differential equation using Finite Difference Method.

**Text Books:**

1. www.python.org
2. www.rosettacode.org
3. http://faculty.msmary.edu/heinold/python.html
4. J. Kiusalaas, Numerical methods in engineering with Python 3. CambridgeUniversity Press, 2013.
5. H. P. Langtangen, Solving PDEs in Python: the FEniCS tutorial I. SpringerOpen, 2016.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Create your first program in Python IDLE.

**CLO2:** Implement OOPs concepts in your programming.

**CLO3:** Use Arrays, and Data structures.

**CLO4**: Create an application with the support of graphics in Python.

**CLO5:** Implement error handling.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| | Course Code:24PMA3IN01 | | Course Title: Internship | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| III | - | - | 2 | 100 |

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-XI** | | **Course Code:24PMA4C11** | **Course Title:** Functional Analysis | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| IV | 6 | 90 | 5 | 100 |

**Course Objectives**

To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques.

**UNIT- I :**

Banach Spaces: The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of $N$ in $N^{**}$- The open mapping theorem – The conjugate of an Operator. Chapter 9:Sections 46-51.

**UNIT- II:**

Hilbert Spaces: The definition and some simple properties–Orthogonal complements–Ortho normal sets–The conjugate space $H^*$-The adjoint of an operator–self-adjoint operators-Normal and unitary operators – Projections. Chapter10:Sections52-59

**UNIT-III:**

Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator – The spectral theorem. Chapter 11:Sections 60-62.

**UNIT-IV:**

General Preliminaries on Banach Algebras**:** The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi-simplicity. Chapter 12:Sections 64-69.

**UNIT-V:**

The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula$r(x) = \lim \|x^n\|^{1/n}$– Involutions in Banach algebras-The Gelfand-Neumark theorem. Chapter 13:Sections 70-73.

**Text Book:**

G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education (India)Private Limited, New Delhi, 1963.

**Reference Books: --**

1. W.Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973.
2. B.V. Limaye, Functional Analysis, New Age International,1996.
3. C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, NewDelhi,1987.
4. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.

5. M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002.
6. W.Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973.
7. B.V. Limaye, Functional Analysis, New Age International,1996.
8. C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, NewDelhi,1987.
9. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
10. M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002.

**Website:** http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

**e-Learning Source:** http://www.opensource.org, http://en.wikiepedia.org

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Understand the Banach spaces and Transformations on Banach Spaces.

**CLO2:** Prove Hahn Banach theorem and open mapping theorem.

**CLO3:** Describe operators and fundamental theorems.

**CLO4:** Validate orthogonal and orthonormal sets.

**CLO5:** Analyze and establish the regular and singular elements.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Core-XII** | **Course Code:24PMA4C12** | | **Course Title:** Differential Geometry | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| IV | 6 | 90 | 5 | 100 |

## Course Objectives

This course introduces space curves and their intrinsic properties of a surface and geodesics. Further the non-intrinsic properties of surface and the differential geometry of surfaces are explored.

**UNIT-I : Space curves:** Definition of a space curve – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations – Fundamental Existence Theorem for space curves- Helies. Chapter I : Sections 1 to 9.

**UNIT-II :Intrinsic properties of a surface:** Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric- Direction coefficients – families of curves- Isometric correspondence- Intrinsic properties**.** Chapter II: Sections 1 to 9.

**UNIT-III : Geodesics:** Geodesics – Canonical geodesic equations – Normal property of geodesics- Existence Theorems – Geodesic parallels – Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature-surface of constant curvature. Chapter II: Sections 10 to 18.

**UNIT-IV :** Non Intrinsic properties of a surface: The second fundamental form- Principle curvature – Lines of curvature – Developable - Developable associated with space curves and withcurves on surface - Minimal surfaces – Ruled surfaces. Chapter III: Sections 1 to 8.

**UNIT-V :Differential Geometry of Surfaces :**

Compact surfaces whose points are umblics- Hilbert‘s lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert‘s Theorem – Conjugate points on geodesics. Chapter IV : Sections 1 to 8 (Omit 9 to 15).

**Text Book:**

T.J.Willmore, *An Introduction to Differential Geometry,* Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print).

**Reference Books:**

1. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison –Wesley, Mass. 1950.
2. Kobayashi. S. and Nomizu. K. *Foundations of DifferentialGeometry,* Inter science Publishers, 1963.
3. Wilhelm Klingenberg: *A course in Differential Geometry*, GraduateTexts in Mathematics, Springer-Verlag 1978.
4. J.A. Thorpe *Elementary topics in Differential Geometry*, Under-graduate Texts in Mathematics, Springer - Verlag 1979.

**Website and e-Learning Source:**
http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.physicsforum.com.

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Explain space curves, Curves between surfaces, metrics on a surface, fundamentalform of a surface and Geodesics.

**CLO2**: Evaluate these concepts with related examples.

**CLO3:** Compose problems on geodesics.

**CLO4:** Recognize applicability of developable.

**CLO5**: Construct and analyze the problems on curvature and minimal surfaces.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| Project | Course Code:24PMAPR1 | | Course Title: Project With Viva Voce | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| IV | 6 | 90 | 7 | 100 |

**Elective VI** to be chosen from **Group F:**

| **Program: M.Sc. Mathematics** | | | | |
|---|---|---|---|---|
| **Elective-VI** (Chosen from Group F) | **Course Code:24PMA4E21** | | **Course Title:** Algebraic Geometry | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| IV | 6 | 90 | 3 | 100 |

**Course Objectives**

The course aims at giving an introduction to classical algebraic geometry, that is, the theory of algebraic varieties, and the most important notions and techinques to study these.

**UNIT-I: Affine algebraic sets**

Affine spaces and algebraic sets, Noetherian rings, Hilbert basis theorem, affine algebraic sets as finite intersection of hypersurfaces; Ideal of a set of points, coordinate ring, morphism between algebraic sets, isomorphism. Integral extensions, Noether‘s normalization lemma

**UNIT-II: Hilbert’s Nullstellensatz and applications**

Correspondence between radical ideals and algebraic sets, prime ideals and irreducible algebraic sets, maximal ideals and points, contrapositive equivalence between affine algebras with algebra homomorphisms and algebraic sets with morphisms, between affine domains and irreducible algebraic sets, decomposition of an algebraic set into irreducible components. Zariski topology on affine spaces, algebraic subsets of the plane.

**UNIT-III: Projective spaces**

Homogeneous coordinates, hyperplane at infinity, projective algebraic sets, homogeneous ideals and projective Nullstellensatz; Zariski topology on projective spaces. Twisted cubic in P_3(k). Local properties of plane curves: multiple points and tangent lines, multiplicity and local rings, intersection numbers; projective plane curves: Linear systems of curves, intersections of projective curves: Bezout‘s theorem and applications; group structure on a cubic.

**UNIT-IV: Introduction to sheaves of affine varieties**

Examples of presheaves and sheaves, stalks, sheafification of a presheaf, sections, structure sheaf, generic stalk and function fields, rational functions and local rings, Affine tangent spaces; Projective varieties and morphisms; Hausdorff axiom.

**UNIT-V: Prime spectrum of a ring**

Zariskitopology, structiureaheaf, affine schemes, morphism of affine schemes. Elementary Dimension Theory, Fibres of a morphism, complete varieties, nonsingularity and regular local rings, Jacobian criterion, nonsingular curves and DVR‘s.

**Text Books:**

1. W.Fulton Algebraic Curves: An introduction to algebraic geometry

2. C. G. Gibson – Elementary Geometry of Algebraic Curves, CUP,
3. D. S. Dummitt and R. M. Foote – Abstract Algebra, Wiley, Ch. 15.

**Reference Books:**

1. J. Harris Algebraic Geometry, A first course, Springer
2. M. Reid Undergraduate algebraic geometry, LMS 12, CUP
3. K. Kendig – Elementary Algebraic Geometry, Springer
4. D. Mumford – The Red Book of Varieties and Schemes, Springer
5. I. R. Shafarevich – Basic Algebraic Geometry, Springer

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** An understanding of the concepts of affine and projective varieties.

**CLO2**: An understanding of schemes.

**CLO3:** The ability to calculate invariants of varieties.

**CLO4:** The ability to solve problems involving varieties by converting them into problems in algebra.

**CLO5**: The ability to pursue further studies in this and related areas.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO2 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 1 |
| CLO4 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 |
| CLO5 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-VI** | | **Course Code:24PMA4E22** | **Course Title:** Financial Mathematics | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| IV | 6 | 90 | 3 | 100 |

**Course Objectives**

- In this course, the students are on posed to The basic concepts ofProbability theory, The Central limit theorem.
- The concepts of Geometric Brownian motion, Option pricing.
- The derivatives of Blackschole formula and its applications.
- The concept of call option on Dividend paying securities, estimatingthe volatility parameter.
- The limitations of Arbitrage pricing, the portfolio selection problem.

**UNIT-I: Stochastic Order Relations**

First-Order Stochastic Dominance -Using Coupling to Show Stochastic Dominance - Likelihood Ratio Ordering -A Single-Period Investment Problem-Second-Order Dominance.

**UNIT-II: Optimization Models**

Introduction- A Deterministic Optimization Model -ProbabilisticOptimization Problems.

**UNIT-III: Stochastic Dynamic Programming**

The Stochastic Dynamic Programming Problem - Infinite Time Models - Optimal Stopping Problems.

**UNIT-IV: Exotic Options**

Introduction -Barrier Options - Asian and Lookback Options - Monte Carlo Simulation -Pricing Exotic Options by Simulation - More Efficient Simulation Estimators.

**UNIT-V: Beyond Geometric Brownian Motion Models**

Introduction -Crude Oil Data - Models for the Crude Oil Data - FinalComments.

**Text Book:**

An Elementary Introduction to Mathematical Finance,2nd EditionSheldon M.Ross Cambridge University press 2005.

**Reference Books:**

1. A First Course in Probability, S.M.Ross, Englewood cliffs PrenticeHallNJ 2002
2. Option Market , J.Cox M.Rubinstein, Englewood cliffs PrenticeHallNJ 1985
3. Theory of Financial decision Making ,J.E.Ingersill ,Lanjarn MD Rowerman of Little Fields 1987

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** A n understanding of the concepts of affine and projective varieties.

**CLO2**: An understanding of schemes.

**CLO3:** The ability to calculate invariants of varieties.

**CLO4:** The ability to solve problems involving varieties by converting them into problems in algebra.

**CLO5**: The ability to pursue further studies in this and related areas.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Elective-VI** | **Course Code:24PMA4E23** | | **Course Title:** Resource Management Techniques | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| IV | 6 | 90 | 3 | 100 |

## Course Objectives

The main aim of HRM is to ensure the right people with the right skills for the right job position in an organization. The main functions of HRM consist of recruiting, training, performance appraisal, motivating employees, ensuring their good health and safety, managing workplace communication, and so on.,

**UNIT-I: Linear Programming**

Principal components of decision problem – Modeling phases – LP Formulation and graphic solution –Resource allocation problems –Simplex method – Sensitivity analysis.

**UNIT-II: Duality And Networks**

Definition of dual problem – Primal – Dual relation ships – Dualsimplex methods – Post optimality analysis – Transportation and assignment model - Shortest route problem.

**UNIT-III: Integer Programming**

Cutting plan algorithm – Branch and bound methods, Multistage(Dynamic) programming.

**UNIT-IV: Classical Optimisation Theory**

Unconstrained external problems, Newton – Ralphson method –Equality constraints – Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

**UNIT-V: Object Scheduling**

Network diagram representation – Critical path method – Time charts and resource leveling – PERT.

**Text Book:**

H.A. Taha, ‑Operation Research‖, Prentice Hall of India, 2002.

**Reference Books:**

1. Paneer Selvam, _Operations Research‘, Prentice Hall of India, 2002.
2. Anderson _Quantitative Methods for Business‘, 8th Edition,Thomson Learning, 2002.
3. Winston _Operation Research‘, Thomson Learning, 2003.
4. Vohra, _Quantitative Techniques in Management‘, Tata Mc GrawHill, 2002.
5. Anand Sarma, _Operation Research‘, Himalaya Publishing House, 2003.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** Make use of simplex method to solve optimization problems.

**CLO2**: Demonstrate the concept of duality to solve Shortest route problem.

**CLO3:** Explain integer programming method.

**CLO4:** Demonstrate the types of constraints and optimization methods.

**CLO5**: Utilize PERT and CPM in project management.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

## SKILL ENHANCEMENT COURSES

Skill Enhancement Courses are chosen so as to keep in pace with the latest developments in the academic / industrial front and provides flexibility of choice by the stakeholders / institutions.

**Group G (Skill Enhancement Courses) SEC**

| **Program: M.Sc. Mathematics** | | | | |
|---|---|---|---|---|
| **SEC** | **Course Code:24PMASEC01** | | **Course Title:** Mathematical Computation With Sagemath | |
| **Semester** | **Hours/Week** | **Total Hours** | **Credits** | **Total Marks** |
| | 6 | 30 | 2 | 100 |

### Course Objectives

Computational Mathematics with SageMath: This twelve week course aims to use SageMath, a Python based free and open source computer algebra system (CAS) to explore concepts in Calculus, Applied Linear Algebra, Numerical Methods and basic Linear Programming Problems.

**UNIT-I: First Steps**
The Sage Program -Sage as a Calculator.

**UNIT-II: Analysis and Algebra**
Symbolic Expressions and Simplification – Equations – Analysis -Basic Linear Algebra.

**UNIT-III: Programming and Data Structures**
Syntax –Algorithmics -Lists and Other Data Structures.

**UNIT-IV: Graphics**
2D Graphics - 3D Curves

**UNIT-V: Computational Domains**
Sage is Object-Oriented- Elements, Parents, Categories-Domainswith a Normal Form-Expressions vs Computational Domains.

**Text Book:**
Mathematical Computation with SageMath ,Paul ZimmermannAlexandre Casamayou.

**Reference Books:**

1. Uri M. Ascher and Linda R. Petzold, Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations. Society for Industrial and Applied Mathematics, 1998, ISBN 0898714128.
2. Noga Alon and Joel H. Spencer, The Probabilistic Method. Wiley-Interscience, 2000, ISBN 0471370460.
3. Bernard Beauzamy, Robust mathematical methods for extremelyrare events. On-line, 2009. http://www.scmsa.eu/RMM/BB_rare_events_2009_08.pdf, 20 pages.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO1:** A browser-based notebook for review and Re-use of previous inputs and outputs, including graphics and text annotations.

**CLO2**: Demonstrate the concept of duality to solve Shortest route problem.

**CLO3:** A text-based command-line interface using IPython.

**CLO4:** Support for parallel processing using multi-core processors, multiple processors, or distributed computing.

**CLO5**: Demonstrate the types of constraints and optimization methods.

.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| **SEC** | | **Course Code:24PMASEC02** | **Course Title:** Advanced LATEX | |
| **Semester** | **Hours/Week** 6 | **Total Hours** 30 | **Credits** 2 | **Total Marks** 100 |

**Course Objectives**

The course aims

- To create understanding of the LaTeX.
- To typeset typical mathematical papers using the article style andfigure out LaTeX errors, download and use packages, create simple diagrams.
- To prepare a short presentation using the beamer class.

**UNIT-I: Introduction and the Structure of a LaTeX Document**

Installation of the software LaTeX - Environments and commands - Classes and packages – Errors - Files created - How to use LAEX at CUED - Document Classes - Arara- Counters and Length parameters - Document and page organization – Page breaks, footnotes. Environments , Matrix-like environments . Chapter - 1 and 2 in I & Chapter - 1 in II ; Chapter – 4 in I & Chapter – 5 in II; Chapter -8 (Section 8.3) in III.

**UNIT-II: Display and alignment structures**

Display and alignment structures for equations Comparison with standard LaTeX - A single equation on one line - A single equation on several lines: no alignment - A Single equation on several lines: with alignment - Equation groups without alignment - Equation groups with simple alignment- Multiple alignments: align and flalign - Display environments as mini-pages- Interrupting displays, Variable symbol commands - Symbols in formulas Chapter – 8 (Section 8.2, 8.5, 8.6 and 8.9) in III.

**UNIT-III: Figures Directly in LaTex**

Inserting Images, Positioning Images, List of Figures, Drawing diagrams directly in LaTex, TikZ package, Graphics and PSTricks Pictures and graphics in LaTeX, simple pictures using PSTricks, Plotting of functions.

**UNIT-IV: Presentations (The beamer Class)**

Overlays -Themes Assignments and Examinations The exam Class - The exsheets Package - The probsoln Package - Using the data tool Package for Exams or Assignment Sheets - Random Numbers. Charts Flow Charts - Pie Charts - The datapie Package - The pgf-pie Package - Bar Charts - The bchart Package - The databar Package - Gantt Charts - Plots . Chapter – 8, 9 and 12 in II .

**UNIT-V: Structuring Your Document**

Author and Title Information, Abstract, Chapters, Sections, Subsections, Creating a Table of Contents, Cross-Referencing, Creating a Bibliography, Page Styles and Page Numbering, Multi- Lingual Support: using the babel package. (5.1-5.7)

**Text Books:**

I. Advanced LATEX by Tim Love, 2006

II. http://www.h.eng.cam.ac.uk/help/documentation/docsource/latex_advanced.pdf

III. LaTeX for Administrative Work by Nicola L. C. Talbot, DickimawBooks, 2015, http://www.dickimaw-books.com/latex/admin/

IV. The LaTeX Companion by Frank Mittelbach and Michel Goossens,Addison-Wesley, Library of Congress Cataloging-in-Publication Data (Second Edition)

V. Nicola L. C. Talbot, LATEX for Complete Novices Version 1.4, Dickimaw Books http://www.dickimaw-books.com/2012.

**Reference Books:**

1) Bindner, Donald & Erickson, Martin. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group, LLC.

2) Lamport, Leslie (1994). LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

3) George Gratzer, More Math into LATEX, 4th Edition, 2007 Springer Science

4) Frank Mittelbach, Michel Goossens, The LaTex Companion, Second Edition, Addision-Wesley, 2004

5) A Primer, Latex, Tutorials, Indian TEX users group, Trivandrum, India.www.tug.org.in

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Learning Outcomes:**

Students will be able to

**CLO1:** This course will enable the students to:

**CLO2:** Create and typeset a LaTeX document

**CLO3:** Typeset a mathematical document

**CLO4:** Draw pictures in LaTeX

**CLO5:** Create beamer presentations and Prepare the projects or dissertations in LaTeX

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| SEC | | Course Code:24PMASEC03 | Course Title: Office Automation and ITC Tools | |
| Semester | Hours/Week<br>6 | Total Hours<br>30 | Credits<br>2 | Total Marks<br>100 |

**Course Objectives**

Office tools course would enable the students in crafting professional word documents, excel spread sheets, power point presentations using the Microsoft suite of office tools. To familiarize the students in preparation of documents and presentations with office automation tools.

**UNIT-I:**

Telecommunication and Word Processor

**UNIT-II:**

WP Hardware Configuration

**UNIT-III:**

Reprographics

**UNIT-IV:**

Electronic Mail and Electronic-Filing

**UNIT-V:**

Facsimile Transmission and Micrographics -Voice Technology

**Text Books:**

1. Office Automation Tools and Technology
2. Office Automation Tools ,Yatendra kumar & suitha varshney, Naveen prakashan pvt .Ltd

**Reference Books:**

1.Office Automation Tools ,Dr.Rizwan Ahmed , Naveen prakashan pvt.Ltd
2.Office Automation Tools, Dr.Babasaheb Ambedkar.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com.

**Learning Outcomes:**

Students will be able to

**CLO1:** To perform documentation

**CLO2:** To perform accounting operations

**CLO3:** To perform presentation skills

**CLO4:** Data Creation & Storage: Important and confidential workplace papers and information can be easily and securely stored.·

**CLO5:** Increased Productivity and High Availability.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| SEC | Course Code:24PMASEC04 | | Course Title: Numerical Analysis Using Scilab | |
| Semester | Hours/Week<br>6 | Total Hours<br>30 | Credits<br>2 | Total Marks<br>100 |

## Course Objectives

Numerical analysis or Scientific computing is the study of approximation techniques for numerically solving mathematical problems. Scilab is based on methods of numerical computation: Data analysis. Algorithm development.

**UNIT-I:**

Transcendental and Polynomial Equations

**UNIT-II:**

System of Linear Algebric Equations and Eigenvalue Problems

**UNIT-III:**

Interpolation and Approximation

**UNIT-IV:**

Differentiation and Integration

**UNIT-V:**

Ordinary Differential Equations Innitial Value Problems

**Text Book:**

Numerical Methods For Scientific And Engineering Computation by M. K. Jain, S. R. K. Iyengar And R. K. Jain

**Reference Book:**

Numerical Methods and principles analysis and algorithms ,S.Pal ,Oxford University Press

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Learning Outcomes:**

Students will be able to

**CLO1:** At the end of the lab course, students will be able to Perform basic mathematical operations using Scilab software.

**CLO2:** Execute loops and conditional statements using Scilab software.

**CLO3:** Demonstrate understanding of common numerical methods

**CLO4:** How they are used to obtain approximate solutions to otherwise intractable mathematical problems.

**CLO5:** Apply numerical methods to obtain approximate solutions to mathematical problems.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| Program: M.Sc. Mathematics | | | | |
|---|---|---|---|---|
| SEC | Course Code:24PMASEC05 | | Course Title: Differential Equations Using Scilab | |
| Semester | Hours/Week<br>6 | Total Hours<br>30 | Credits<br>2 | Total Marks<br>100 |

**Course Objectives**

Perform basic mathematical operations using Scilab softwarewith understand that physical systems can be described by differential equations. understand the practical importance of solving differential equations. understand the differences between initial value and boundary value problems (IVPs and BVPs

**UNIT-I:**

An Introduction to Scilab - Matrices

**UNIT-II:**

Scilab Programming

**UNIT-III:**

Functions -Plotting

**UNIT-IV:**

Solving Ordinary Differential Equations

**UNIT-V:**

Polynomials in Scilab

**Text Book:**

Programming Using Scilab, Akhilesh Kumar.

**Reference Book:**

Ordinary Differential Equations with Scilab by Gilberto E.Urroz.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

**Learning Outcomes:**

Students will be able to

**CLO1:** Perform basic mathematical operations using Scilab software.

**CLO2:** Ordinary differential equations applications in real life are used to calculate the movement or flow of electricity.

**CLO3:** The motion of an object to and fro like a pendulum, to explain thermodynamics concepts.

**CLO4:** Also, in medical terms, they are used to check the growth of diseases in graphical representation.

**CLO5:** Execute loops and conditional statements using Scilab software.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| SEC | | Course Code:24PMASEC06 | Course Title: Industrial Mathematics using Latest Programming packages | |
|---|---|---|---|---|
| **Semester** | **Hours/Week** 6 | **Total Hours** 30 | **Credits** 2 | **Total Marks** 100 |

## Course Objectives

Applied and Industrial Mathematics aims to solve real-world problems in Science, Engineering, Medicine, and Finance. It enhances your critical thinking skills and is integral to every scientific endeavour. Applied and Industrial Mathematics is fundamental to problem-solving.

**UNIT-I:**

Mathematics in industry- Overview of the case studies-Units and dimensions - Diffusion equations - Heat conduction equations

**UNIT-II:**

Boundary conditions -Solving the heat/diffusion equation -Scalingequations - Dimensional analysis

**UNIT-III:**

Continuous Casting - Introduction to the case study problem - The Boltzmann similarity solution- A moving boundary problem - The pseudo- steady-state approximate solution-Solving the continuous casting case study

**UNIT-IV:**

Water Filtration - Introduction to the case study problem -Stretching transformations - Diffusion from a point source -Solving the waterfiltration case study.

**UNIT-V:**

Laser Drilling -Introduction to the case study problem - Method of perturbations -Boundary perturbations - Solving the laser drilling casestudy.

**Text Book:**

Industrial Mathematics Case Studies in the Diffusion of Heat and Matter,GLENN R. FULFORD PHILIP BROADBRIDGE.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Learning Outcomes:**

Students will be able to

**CLO1:** Develop own methods of performing operations on numbers in daily life (addition, subtraction, multiplication and division).

**CLO2:** Develop language and symbolic notations with standard algorithms of performing number operations.

**CLO3:** Estimate outcome of operations on two or more numbers and use it in daily life activities.

**CLO4:** The course is designed to prepare students to undertake careers involving problem solving in mathematics using computer science and technologies.

**CLO5:** To pursue advanced studies and research in mathematics using computer science.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

| SEC | | Course Code:24PMASEC07 | Course Title: Research Tools And Techniques | |
|---|---|---|---|---|
| Semester | Hours/Week<br>6 | Total Hours<br>30 | Credits<br>2 | Total Marks<br>100 |

## Course Objectives

This course addresses the issues inherent in selecting a research problem and discuss the techniques and tools to be employed in completing a research project. This will also enable the students to prepare report writing and framing Research proposals.

**UNIT-I:**

Research Process- Research Design

**UNIT-II:**

Research Problem-Variables and Their Types

**UNI- III:**

Formulation of Hypothesis– Sampling- Tools of Data Collection

**UNIT-IV:**

Data Analysis- Interpretation of Data

**UNIT-V:**

Research Methods - Descriptive or Survey Method - ExperimentalMethod

**Text Book:**

RESEARCH METHODOLOGY: TOOLS AND TECHNIQUES Dr. Prabhat Pandey Dr. Meenu Mishra Pandey © Bridge Center, 2015.

**Reference Books:**

1. Ackoff, Russell L. (1961). The Design of Social Research,University of Chicago Press: Chicago.
2. Allen, T. Harrell, (1978). New Methods in Social Research, PraegerPublication: New York.
3. Baker, R.P. & Howell, A.C. (1958). The Preparation of Reports,Ronald Press: New York.
4. Barzun, Jacques & Graff. F. (1990).The Modern Researcher,Harcourt, Brace Publication: New York.
5. Berelson Conard & Colton, Raymond. (1978). Research and Report Writing for Business and Economics, Random House: New York.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Learning Outcomes:**

Students will be able to

**CLO1:** Demonstrate the ability to choose methods appropriate to research aims and objectives.

**CLO2:** Understand the limitations of particular research methods.

**CLO3:** Develop skills in qualitative and quantitative data analysis and presentation.

**CLO4:** Develop advanced critical thinking skills.

**CLO5:** To pursue advanced studies and research in mathematics using computer science.

| | POs | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

Strong:3 Medium:2 Low:1

## EXTRA DISCIPLINARY COURSES FOR OTHER DEPARTMENTS

## (NOT FOR MATHEMATICS STUDENTS)

Students from other Departments may also choose any one of the following as ExtraDisciplinary Course.

| ED-I | | Course Code:24PMAED01 | Course Title: Mathematics For Life Sciences | |
|---|---|---|---|---|
| **Semester** | **Hours/Week** 6 | **Total Hours** 30 | **Credits** 2 | **Total Marks** 100 |

### Course Objectives

1. The focus of the course is on scientific study of normal functions in living systems. The emphasis is on exposure to nonlinear differentialequations with examples such as heartbeat, chemical reactions and nerve impulse transmission.
2. The basic concepts of the probability to understand molecular evolution and genetics have also been applied.

**UNIT-I:** Cell Growth-Exponential growth and Decay – Determination of growth or decay rates-The method of least squares – Nutrient Uptake by a cell –Inhomogeneous Differential equations.

**UNIT-II:** Growth of a Microbial colony – Growth in a Chemo stat – Interacting Populations – Mutation and Reversion in Bacterial growth.

**UNIT-III:** Enzyme Kinematics: The Michaelis – Menton Theory – Enzyme Substrate – Inhibitor system – Cooperative dimmer – Allosteric enzymes – Other alloseteric theories.

**UNIT-IV:** The Cooperative dimmer – Allosteric enzymes – Other allosetherictheories.

**UNIT-V:** Hemoglobin – Graph theory and Steady state Enzyme Kinetics –Enzyme – Substrate – Modifier system – Enzyme Substrate – Activator system.

**Text Book:**

S. I. Rubinow, Introduction Mathematical Biology, Dover publications, NewYork, 1975. Chapter I and Chapter 2 (Sections 2.1,2.3, to 2.11).

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** analysis and interpretation of bio mathematical models such as Population growth, celldivision, and predator-prey models.

**CLO 2:** apply the basic concepts of probability to molecular evolution and genetics.

**CLO 3:** Identify and appreciate the unifying influence of mathematical modelling in differentdisciplines

**CLO 4:** Explain Allosteric enzymes

**CLO 5:** Analyze and translate a real-world problem into a mathematical problem

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| CLO2 | 2 | 1 | 2 | 3 | 2 | 1 | 3 | 2 | 1 |
| CLO3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| CLO4 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 1 |
| CLO5 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| ED-II | | Course Code:24PMAED02 | Course Title: Mathematics For Social Sciences | |
|---|---|---|---|---|
| Semester | Hours/Week<br>6 | Total Hours<br>30 | Credits<br>2 | Total Marks<br>100 |

## Course Objectives

Provide students with mathematical foundations to understand advanced statistical methods. Cover key mathematical principles in an applied context, using social science examples and real data.

**UNIT-I: Propositional Logic and set Theory**

Propositional Logic Propositional Logic -Open propositions and quantifiers -Arguments and Validity - Set Theory

**UNIT-II: Functions**

The real number system - Solving equations and inequalities; linear and quadratic equations - Review of relations and functions

**UNIT-III:**

Real valued functions and their properties -Types of functions and
inverse of a function - Polynomials, zeros of polynomials, rationalfunctions and their graphs

**UNIT-IV:**

Definition and basic properties of logarithmic, exponential, trigonometricfunctions and their graph

**UNIT-V: Matrices and determinant**

Definition of a matrix -Matrix Algebra -Types of matrices - Elementary row operations - Row echelon form and reduced row echelon form of a matrix

**Text Book:**

Mathematics for Social Sciences , Dr. Berhanu Bekele, Ato MulugetaNaizghi

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Provide students with mathematical foundations to understand advanced statistical methods

**CLO 2:** Cover key mathematical principles in an applied context, using social science examples and real data

**CLO 3:** Understand the mathematics behind least squares estimation; principal components; and logistic regression.

**CLO 4:** Understand how establishing statistical certainty relies on differential and integral Calculus.

**CLO 5:** To engage critically with the challenges in capturing and understanding the world with quantitative methods.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| CLO2 | 2 | 1 | 2 | 3 | 2 | 1 | 3 | 2 | 1 |
| CLO3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| CLO4 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 1 |
| CLO5 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| ED-III | Course Code:24PMAED03 | | Course Title: Statistics For Life And Social Sciences | |
|---|---|---|---|---|
| **Semester** | **Hours/Week** 6 | **Total Hours** 30 | **Credits** 2 | **Total Marks** 100 |

## Course Objectives

The main objective of this course is to introduce students the knowledge of real field and its properties. It will provide grounds for Probability Theory and help them in theoretical and applied researches in Statistics.

**UNIT-I:**

Definitions, and Scope of Statistics -Approach to Data Collection -Introduction to Set Theory I & II -Concepts of Logic.

**UNIT-II:**

Diagrammatic Presentation of Data -Frequency Distribution - Graphical Presentation of Data - Measures of Central Tendency.

**UNIT-III:**

Probability Theory I&II - Permutation Theorem -Combination -Binominal Distribution.

**UNIT-IV:**

Nature and Importance of Statistical Inquiries - Basic ResearchMethodology I & II

**UNIT-V:**

Nature of Science -Some Basic Concepts in Social Statistics

**Text Book:**

BASIC STATISTICS FOR SOCIAL SCIENCES ,Dr. Henry Obasogie (Course Reviewer) – Benson Idahosa University Dr. Moses Etila Shaibu (CourseEditor) – NOUN

**Reference Books:**

1. Osuala, E.C.(1982). Introduction to Research Methodology. AwkaRd Onitsha, Nigeria: Africana-Fep Publisher Limited.
2. Okoro, E. (2002). Quantitative Techniqes in Urban Analysis. Ibadan:Kraft Books Ltd. Kerlinger, Fred N. (1964). .
3. Foundations of Behavioural Research. New York: Holt, Rinehart andWinton. Whitney, F.L. (1968).
4. The Elements of Research. New York: Prentice- Hall.

**Website and e-Learning Source:**

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Recognise which analysis procedure is appropriate for a given research problem involving one or two variables

**CLO 2:** Understand principles of study design

**CLO 3:** Apply probability theory to practical problems

**CLO 4:** Apply statistical procedures on a computer using Microsoft Excel and/or R

**CLO 5:** Interpret computer output for a statistical procedure

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| CLO2 | 2 | 1 | 2 | 3 | 2 | 1 | 3 | 2 | 1 |
| CLO3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| CLO4 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 1 |
| CLO5 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 1 |

Strong:3 Medium:2 Low:1

| ED-IV | | Course Code:24PMAED04 | Course Title: Game Theory and Strategy | |
|---|---|---|---|---|
| Semester | Hours/Week<br>6 | Total Hours<br>30 | Credits<br>2 | Total Marks<br>100 |

## Course Objectives

1. It focuses on fundamentals of game theory including basic concepts and techniques, various ways of describing and solving games, and various applications in economics, political sciences, and business.
2. It will help students sharpen their understanding of strategic behavior in different situations involving many individuals. T
3. The students will learn how to recognize and model strategic situations, to predict when and how their action will have an influence on others, and to exploit strategic situations for the benefit of their own.

**UNIT-I:**

Game, Strategy and Saddle Point: Introduction- Description of a game of strategy- Relations among expectations- Saddle points-Game with perfect information's. Chapter 1.

**UNIT-II:**

The Fundamentals: Game without saddle points-mixed strategies- Graphical representation of mixed strategies – the minimax theorem – optimal mixed strategy – graphical representation of minimax theorem and proof of minimax theorem. Chapter 2.

**UNIT-III:**

Properties of Optimal Strategies: Many optimal strategies – some properties of an optimal strategies – convex set of optimal strategies- operation on games – dominated strategies – all strategies active. Chapter 3 (Section 3.1 to 3.6).

**UNIT-IV:**

Method of Solving games: Solving for optimal strategies – Guess and verify – Examination of submatrices – Successive approximations –Graphical solutions of 3 x 3 games. Chapter 5 (Section 5.1 to 5.5)

**UNIT-V:**

Mapping method for solving games with constraints – Mapping method for solving games – solution of reconnaissance game by mapping method. Chapter 5 (Section 5.6 to 5.8).

**Text Book:**

Melvin Dresher, Game of Strategy Theory and Application, Prentice-Hall-Inc, USA, 1961.

**Reference Books:**

1. Kanti Swarup, P.K.Gupta and Man Mohan, –Operations Research, Eighth Edition‖, Sultan Chand & Sons, New Delhi, 1999.
2. S.Hillier and J.Liebermann, Operations Research, Sixth Edition, McGraw Hill Company, 1995.
3. J. K. Sharma, Operations Research problems and solution, Thirdedition, Mackmillan Publishers India Ltd, India, 2012.
4. Guillermo Owen, Game Theory, 2nd edition, Academic Press, 1982.
5. Philip D. Straffin, Game Theory and Strategy, The MathematicalAssociation of America, USA, 1993.

**Website and e-Learning Source:**

1. https://nptel.ac.in/courses/110101133
2. https://archive.nptel.ac.in/courses/110/104/110104063/

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Distinguish a game situation from a pure individual‘s decision problem.

**CLO 2:** Explain graphical representation of mixed strategies.

**CLO 3:** Explain concepts of dominant, dominated, and rationalizable strategies, pure and mixedstrategies, and best responses.

**CLO 4:** Analyse economic situations using game theoretic techniques.

**CLO 5**: Solve simple games using mapping method.

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| CLO2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| CLO4 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| CLO5 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 |

Strong:3 Medium:2 Low:1

| ED-V | Course Code:24PMAED05 | | Course Title: History Of Mathematics | |
|---|---|---|---|---|
| **Semester** | **Hours/Week** 6 | **Total Hours** 30 | **Credits** 2 | **Total Marks** 100 |

**Course Objectives**

The objectives (and outcomes) for math history courses also include clear, critical, creative, and flexible thinking, and an appreciation for the beauty and joy of mathematics. It is important for students to develop an understanding of mathematics both as a science and as an art.

**UNIT-I:**

Early Number Systems and Symbols

**UNIT-II:**

Mathematics in Early Civilizations

**UNIT-III:**

The Beginnings of Greek Mathematics

**UNIT-IV:**

The Alexandrian School: Euclid

**UNIT-V:**

The Twilight of Greek Mathematics: Diophantus

**Text Book:**

The History of Mathematics , Seventh Edition David M. Burton Universityof New Hampshire.

**Reference Books:**

1. Aczel, Amer. The Artist and the Mathematician: The Story of NicolasBourbaki, the Genius Mathematician Who Never Existed. New York: Thunder‘s Mouth Press, 2006.
2. Appel, Kenneth, and Haken, Wolfgang. ―Every Planar Map Is Four Colorable.‖ Journal of Recreational Mathematics 9 (1976–1977): 161–169.

**Website and e-Learning Source:**

1. http://www.dcs.warwick.ac.uk/bshm/
2. http://www.maths.tcd.ie/pub/HistMath/HistMath.html

**Course Learning Outcome (for Mapping with POs and PSOs)**

Students will be able to

**CLO 1:** Explain mathematics in ancient Egypt and Mesopotamia

**CLO 2:** Explain ancient Egyptian number system and geometry

**CLO 3:** Explain sexagesimal number system

**CLO 4:** Explain algebra and geometry in Mesopotamia

**CLO 5**: Explain mathematical studies in ancient Greek

| | Pos | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| CLO1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| CLO2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CLO3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| CLO4 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| CLO5 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 |

Strong:3 Medium:2 Low:1