**M.Sc.,**

**MATHEMATICS**

**SYLLABUS**

**from the acadmic year**

**2023-2024**

**TAMIL NADU STATE COUNCIL FOR HIGHER EDUCATION**

**CHENNAI – 600 005.**

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# Testing Pattern

# Different Types of Courses

# Elective Courses (ED from other Department Experts)

# Skill Development Courses

# Institution-Industry-Interaction

1. **Model Syllabus**

Three domains:

(i)Cognitive Domain

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

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

1. Affective Domain
2. Psychomotor Domain

|  |  |
| --- | --- |
| **TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION** | |
| **Programme** | **M.Sc., Mathematics** |
| **Programme Code** |  |
| **Duration** | **PG - 2 years** |
| **Programme Outcomes (Pos)** | **PO1: Problem Solving Skill**  Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.  **PO2: Decision Making Skill**  Foster analytical and critical thinking abilities for data-based decision-making.  **PO3: Ethical Value**  Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.  **PO4: Communication Skill**  Ability to develop communication, managerial and interpersonal skills.  **PO5: Individual and Team Leadership Skill**  Capability to lead themselves and the team to achieve organizational goals.  **PO6: Employability Skill**  Inculcate contemporary business practices to enhance employability skills in the competitive environment.  **PO7: Entrepreneurial Skill**  Equip with skills and competencies to become an entrepreneur.  **PO8: Contribution to Society**  Succeed in career endeavors and contribute significantly to society.  **PO 9 Multicultural competence**  Possess knowledge of the values and beliefs of multiple cultures and  a global perspective.  **PO 10: Moral and ethical awareness/reasoning**  Ability to embrace moral/ethical values in conducting one’s life. |
| **Programme Specific Outcomes**  **(PSOs)** | **PSO1 – Placement**  To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.  **PSO 2 - Entrepreneur**  To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.  **PSO3 – Research and Development**  Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.  **PSO4 – Contribution to Business World**  To produce employable, ethical and innovative professionals to sustain in the dynamic business world.  **PSO 5 – Contribution to the Society**  To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

**Template for P.G., Programmes**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester–I** | **Credit** | **Hours** | **Semester-II** | **Credit** | **Hours** | **Semester-III** | **Credit** | **Hours** | **Semester–IV** | **Credit** | **Hours** |
| 1.1. Core-I | 5 | 7 | 2.1. Core-IV | 5 | 6 | 3.1. Core-VII | 5 | 6 | 4.1. Core-XI | 5 | 6 |
| 1.2 Core-II | 5 | 7 | 2.2 Core-V | 5 | 6 | 3.2 Core-VIII | 5 | 6 | 4.2 Core-XII | 5 | 6 |
| 1.3 Core – III | 4 | 6 | 2.3 Core – VI | 4 | 6 | 3.3 Core – IX | 5 | 6 | 4.3 Project with viva voce | 7 | 10 |
| 1.4 Discipline Centric  Elective -I | 3 | 5 | 2.4 Discipline Centric  Elective – III | 3 | 4 | 3.4 Core – X | 4 | 6 | 4.4Elective - VI (Industry / Entrepreneurship)  20% Theory  80% Practical | 3 | 4 |
| 1.5 Generic Elective-II: | 3 | 5 | 2.5 Generic Elective -IV: | 3 | 4 | 3.5 Discipline Centric Elective - V | 3 | 3 | 4.5 Skill Enhancement course / Professional Competency Skill | 2 | 4 |
|  |  |  | 2.6 NME I | 2 | 4 | 3.6 NME II | 2 | 3 | 4.6 Extension Activity | 1 |  |
|  |  |  |  |  |  | 3.7 Internship/ Industrial Activity | 2 | - |  |  |  |
|  | **20** | **30** |  | **22** | **30** |  | **26** | **30** |  | **23** | **30** |
| **Total Credit Points -91** | | | | | | | | | | | |

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

**for all Post – Graduate Courses including Lab Hours**

**First Year – Semester – I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – I | 5 | 7 |
| Core – II | 5 | 7 |
| Core – III | 4 | 6 |
| Elective – I | 3 | 5 |
| Elective – II | 3 | 5 |
|  |  | **20** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – IV | 5 | 6 |
| Core – V | 5 | 6 |
| Core – VI | 4 | 6 |
| Elective – III | 3 | 4 |
| Elective – IV | 3 | 4 |
| Skill Enhancement Course [SEC] - I | 2 | 4 |
|  |  | **22** | **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 |
| Skill Enhancement Course - 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 | 10 |
| Elective – VI (Industry Entrepreneurship) | 3 | 4 |
| Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
| Extension Activity | 1 | - |
|  |  | **23** | **30** |

**Total 91 Credits for PG Courses**

**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)  **CO1:**  **CO2:**  **CO3:**  **CO4:**  **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 Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (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:**   * **Recommended Texts** * **Reference Books** * **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** |
|  |  |

* + - 1. **Laboratory Activities**
      2. **Field Study Activities**
      3. **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** | **Weightage** | **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% |

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2. Students Name List
3. Time Table
4. Syllabus
5. Lesson Plan
6. Staff Workload
7. Course Design(content, Course Outcomes(COs), Delivery method, mapping of COs with Programme Outcomes(POs), Assessment Pattern in terms of Revised Bloom’s Taxonomy)
8. Sample CO Assessment Tools.
9. Faculty Course Assessment Report(FCAR)
10. Course Evaluation Sheet
11. Teaching Materials(PPT, OHP etc)
12. Lecture Notes
13. Home Assignment Questions
14. Tutorial Sheets
15. Remedial Class Record, if any.
16. Projects related to the Course
17. Laboratory Experiments related to the Courses
18. Internal Question Paper
19. External Question Paper
20. Sample Home Assignment Answer Sheets
21. Three best, three middle level and three average Answer

sheets

1. Result Analysis (CO wise and whole class)
2. Question Bank for Higher studies Preparation

(GATE/Placement)

1. List of mentees and their academic achievements

**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 | 7 |
| CC2 - Real Analysis I | 5 | 7 |
| CC3 - Ordinary Differential Equations | 4 | 6 |
| Elective I(Generic / Discipline Specific)(One from Group A)  Number theory and Cryptography | 3 | 5( 4L + 1T ) |
| Elective II(Generic / Discipline Specific)(One from Group B)  Mathematical Programming | 3 | 5( 4L + 1T ) |
|  | **Total** | **20** | **30** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Semester-II** | **Credit** | **Hours per week(L/T/P)** |
| Part A | CC4 – Advanced Algebra | 5 | 6 |
| CC5 – Real Analysis II | 5 | 6 |
| CC6 - Partial Differential Equations | 4 | 6 |
| Elective III (Generic / Discipline Specific)(One from Group C)  Mathematical Statistics | 3 | 4 |
| Elective-IV(Computer / IT related) (One from Group D)  Modelling and Simulation with Excel | 3 | 4 |
| Part B | Skill Enhancement Course -SEC 2 (One from Group G) | 2 | 4 |
|  | **Total** | **22** | **30** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Second Year - Semester-III** | **Credit** | **Hours per week(L/T/P)** |
| Part A | CC7 - Complex Analysis | 5 | 6 |
| CC8 - Probability Theory | 5 | 6 |
| CC9 – Topology | 5 | 6 |
| CC10 - Industry Modules | 4 | 6 |
| Elective V(Generic / Discipline Specific)(One from Group E)  Mathematical Python | 3 | 3 |
| Part B | Skill Enhancement Course -SEC 3 :Professional Communication Skill -Term paper & Seminar presentation | 2 | 3 |
| Internship / Industrial Activity  (Carried out in Summer Vacation at the end of I year – 30 hours) | 2 |  |
|  | **Total** | **26** | **30** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Semester-IV** | **Credit** | **Hours per week (L/T/P)** |
| Part A | CC11–Functional Analysis | 5 | 6 |
| CC12 - Differential Geometry | 5 | 6 |
| Project with viva voce | 7 | 10 |
| Elective VI(Generic / Discipline Specific)(One from Group F)  Resource Management Techniques | 3 | 4 |
| Part B | Professional Competency Skill Enhancement Course  Training for Competitive Examinations   * Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours) * General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours)   OR Mathematics for Advanced Research Studies (4 hours) | 2 | 4 |
| Part C | Extension Activity | 1 |  |
|  | **Total** | **23** | **30** |

**TOTAL CREDITS: 91**

**Consolidated Table for Credits Distribution**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PART A | 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 |
| Core | 4 | 12 | 48 | 72 | 80  (CGPA) |
| Project with viva voce | 3 | 1 | 3 |
| Industry aligned Programmes- | 3 | 1 | 3 |
| 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 | 4 | 8 | 8 |
| PART B  (ii)  (iii) | Ability Enhancement (Soft skill) | 2 | 4 | 8 | 10 | 11  (Non CGPA) |
| Summer Internship | 1 | 2 | 2 |
| PART C | Extension Activity | 1 | 1 | 1 | 1 |
|  | | | | |  | 91 |

**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 | 7 Hrs | 5 |
| Core II | |  | 25 | | 75 | 7 Hrs | 5 |
| Core III | |  | 25 | | 75 | 6 Hrs | 4 |
| Elective I | | Elective-I  (Choose one from Group-A) | 25 | | 75 | 5 Hrs | 3 |
| Elective II | | Elective-I I  (Choose one from Group-B) | 25 | | 75 | 5 Hrs | 3 |
| Semester-II | | | | | | | | |
| Part A | Core IV |  | | 25 | | 75 | 6 Hrs | 5 |
| Core V |  | | 25 | | 75 | 6 Hrs | 5 |
| Core VI |  | | 25 | | 75 | 6 Hrs | 4 |
| Elective III | Elective-III  (Choose one from Group-C) | | 25 | | 75 | 4 Hrs | 3 |
| Elective IV | Elective-IV  (Choose one from Group-D) | | 25 | | 75 | 4 Hrs | 3 |
| Part B | Skill Enhancement Course -SEC 2 | (Choose one from Group-G) | | | Internal Assessment | | | 2 |
| 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 | 6 Hrs | 4 |
| Core Industry Module | ED-IV  (Choose from outside the Department) | | 25 | | 75 | 3 Hrs | 3 |
| Part B |  | | | | | | | |
|  | Skill based  (Term paper and Seminar) | Assignment of problem by the faculty  Lecture -I (by the student) 25%  Lecture-II (by the student) 25%  Lecture-III (by the student) 25%  Submission of a write-up ( 10-15 pages using LaTeX) 25%  Marks / Grade Point/ Letter Grade as per the Regulation) | | | | | | 2 |
| Ability Enhancement Course (AECC 3) | Soft Skill III | | | Performance based assessment | | | 2 |
| Internship / Industrial - Vacation Activity | | | | | | | 2 |
| Semester-IV | | | | | | | | |
| Part A | Core X |  | | 25 | | 75 | 3 Hrs | 4 |
| Core XI |  | | 25 | | 75 | 3 Hrs | 4 |
| Core XII |  | | 25 | | 75 | 3 Hrs | 4 |
| Project with viva voce XIII |  | | 25 | | 75 | 3 Hrs | 3 |
| Elective VI | Elective-VI  (Choose one from  Group – F) | | 25 | | 75 | 3 Hrs | 3 |
| Part B | Skill Enhancement Course -SEC 4 | Professional Competency Skill Enhancement Course | | Internal Assessment | | | | 2 |
| Ability Enhancement Course (AECC4) | Soft Skill IV | | | Performance based assessment | | | 2 |
| Part C | Extension Activity | Performance based assessment | | | | | | 1 |
| **Total Credits** | | | | | | | | **91** |

**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

**Ability Enhancement Courses**

* Soft Skill courses

**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 |
| Lab Practice Courses | 45 | 15 | 30 | 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**  **Passing Minimum: 50%**  **Duration : Three Hours** |
|  | **Part –A** (**10x 2 = 20 Marks**)  Answer ALL questions  **Each Question carries 2mark** |
| Memory Recall / Example/  Counter Example / Knowledge about the Concepts/ Understanding | Two questions from each UNIT |
|  | Question 1 to Question 10 |
|  | **Part – B (5 x 5 = 25 Marks)**  **Answer ALL questions**  **Each questions carries 5 Marks** |
| Descriptions/ Application  (problems) | Either-or Type Both parts of each question from the same UNIT |
|  | **Question 11(a) or 11(b)**  To  **Question 15(a) or 15(b)** |
|  | **Part-C (3x 10 = 30 Marks)**  **Answer any THREE questions** Each question carries 10 Marks |
| Analysis /Synthesis / Evaluation | There shall be FIVE questions covering all the five units |
|  | **Question 16 to Question 20** |

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. Algebra

2. Real Analysis

3. Ordinary Differential Equations

4. Partial Differential Equations

5. Topology

6. Complex Analysis

7. Mechanics

8. Functional Analysis

9. Differential Geometry and more

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

1. Discrete Mathematics
2. Number Theory and Cryptography
3. Formal Languages and Automata Theory
4. Programming in C++ and Numerical Methods
5. Fuzzy Sets and Their Applications
6. Mathematical Programming
7. Algebraic Number Theory
8. Java Programming
9. Analytical Number Theory
10. Tensor Analysis and Relativity
11. Stochastic Processes
12. Algebraic Geometry
13. Fluid Dynamics
14. Financial Mathematics
15. Wavelets
16. Mathematical Statistics and more

**(iii)Elective Courses (ED from other Department Experts)**

**(iv) Skill Development Courses**

**(v) Institution-Industry-Interaction ( Industry aligned Courses)**

Programmes /course work/ field study/ Modelling the Industry Problem/ Statistical Analysis / Commerce-Industry related problems / MoU with Industry and the like activities.

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Title of the Course | | ALGEBRAIC STRUCTURES | | | | | | | | |
| Paper Number | | CORE I | | | | | | | | |
| **Category** | Core | Year | I | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | I | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | UG level Modern Algebra | | | | | | | | |
| **Objectives of the Course** | | To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms | | | | | | | | |
| **Course Outline** | | **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)** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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://www.mathforum.org), <http://ocw.mit.edu/ocwweb/Mathematics>,  <http://www.opensource.org>, [www.algebra.com](http://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

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|  | 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: Medium: Low:

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| Title of the Course | | REAL ANALYSIS I | | | | | | | | |
| Paper Number | | CORE II | | | | | | | | |
| **Category** | Core | Year | I | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | I | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | UG level real analysis concepts | | | | | | | | |
| **Objectives of the Course** | | 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. | | | | | | | | |
| **Course Outline** | | **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** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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://www.mathforum.org), <http://ocw.mit.edu/ocwweb/Mathematics>,  <http://www.opensource.org>, [www.mathpages.com](http://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.

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|  | 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 |

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| Title of the Course | | ORDINARY DIFFERENTIAL EQUATIONS | | | | | | | | |
| Paper Number | | CORE III | | | | | | | | |
| **Category** | Core | Year | I | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | I | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | UG level Calculus and Differential Equations | | | | | | | | |
| **Objectives of the Course** | | 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 | | | | | | | | |
| **Course Outline** | | **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)** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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://www.mathforum.org), <http://ocw.mit.edu/ocwweb/Mathematics>,  <http://www.opensource.org>, [www.mathpages.com](http://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.

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| 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 |

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| Title of the Course | | ADVANCED ALGEBRA | | | | | | | | |
| Paper Number | | CORE IV | | | | | | | | |
| **Category** | Core | Year | I | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | II | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 5 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | Algebraic Structures | | | | | | | | |
| **Objectives of the Course** | | To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra. | | | | | | | | |
| **Course Outline** | | **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** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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://www.mathforum.org), <http://ocw.mit.edu/ocwweb/Mathematics>,  <http://www.opensource.org>, [www.algebra.com](http://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.

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|  | POs | | | | | | PSOs | | |
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| 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 |

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| Title of the Course | | REAL ANALYSIS II | | | | | | | | |
| Paper Number | | CORE V | | | | | | | | |
| **Category** | Core | Year | I | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | II | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | Elements of Real Analysis | | | | | | | | |
| **Objectives of the Course** | | To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus. | | | | | | | | |
| **Course Outline** | | **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 Rn to R1  **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)** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | * + - 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://www.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.

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|  | POs | | | | | | PSOs | | |
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| 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 |

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| Title of the Course | | PARTIAL DIFFERENTIAL EQUATIONS | | | | | | | | |
| Paper Number | | CORE VI | | | | | | | | |
| **Category** | Core | Year | I | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | I | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | UG level partial differential equations | | | | | | | | |
| **Objectives of the Course** | | To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems. | | | | | | | | |
| **Course Outline** | | **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** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third 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://www.mathforum.org), <http://ocw.mit.edu/ocwweb/Mathematics>,  <http://www.opensource.org>, [www.mathpages.com](http://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

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|  | 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 |

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| Title of the Course | | COMPLEX ANALYSIS | | | | | | | | |
| Paper Number | | CORE VII | | | | | | | | |
| **Category** | Core | Year | II | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | III | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | UG level Complex Analysis | | | | | | | | |
| **Objectives of the Course** | | To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy’s theorem and evaluation of definite integral and harmonic functions | | | | | | | | |
| **Course Outline** | | 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** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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** | | [http://mathforum.org](http://www.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:** 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 .

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|  | 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 |

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| Title of the Course | | PROBABILITY THEORY | | | | | | | | |
| Paper Number | | CORE VIII | | | | | | | | |
| **Category** | Core | Year | II | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | III | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | UG level algebra and calculus | | | | | | | | |
| **Objectives of the Course** | | 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. | | | | | | | | |
| **Course Outline** | | 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. **Chapter 4 : Sections 4.1 to 4.7** | | | | | | | | |
| 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)** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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://www.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.

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|  | 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 |

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| Title of the Course | | TOPOLOGY | | | | | | | | |
| Paper Number | | CORE IX | | | | | | | | |
| **Category** | Core | Year | II | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | III | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | Real Analysis | | | | | | | | |
| **Objectives of the Course** | | To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms. | | | | | | | | |
| **Course Outline** | | **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.** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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://www.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).

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|  | 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 |

# Title of the Course: CORE INDUSTRY MODULES

# Paper Number: CORE X

**Suggestive topics for Core Industry Modules:**

**Industrial Statistics**

**Recommended Text:**

1. Papoulis A. Probability, Random Variables and Stochastic process, Tata McGraw Hill Education Pvt. Ltd., New Delhi
2. Baisnab A., Jas M., Elements of Probability and Statistics, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 1993
3. Fruend John E, Mathematical Statistics, Prentice Hall of India, New Delhi
4. **Industrial Processes**

**Recommended Text:**

1. H.A.Strobel, Chemical Instrumentation: A Systematic approach, 2nd Edition (1973) Addition Wesley, Reading, Mass
2. R.L.Pecsok, L.D. Shields, T.Cavins and L.C.Mcwilliam, 2nd Edition (1976), john Wiley & Sons, New York
3. E.W.Berg, Chemical Methods of Separations, 1st Edition (1963), McGraw Hill, New York
4. **Chemometrics and quality control in industry**

**Recommended Text:**

1. G.D.Christian, Analytical chemistry, 5th edition (1994), John Wiley & Sons, New York
2. M.A. Sharat and D.L. Illuran, Chemometrics, John Wiley, New York
3. Canlcutt and R. Roddy, Statistics for Analytical Chemists, Chapmam and Hall, New York
4. **Mathematics of Finance and Insurance**

**Recommended Text:**

1. John C.Hull, Options, Futures and Other Derivatives, Prentice Hall of India Private Limited
2. Sheldon M Ross, An Introduction to the Mathematical Finance, Cambridge University Press
3. Salih N. Nettci, An introduction to the Mathematics of Financial Derivatives, Academic Press, Inc.
4. Robert J.Ellicott and P.Ekkehardkopp, Mathematics of Financial Markets, Springer-Verlag, New York
5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.
6. Tornasz Rolski, Hanspter Schmidli, Volker Schmidt and Jozef Teugels, Stochastic Processes for insurance and Finance, John Wiley & Sons Limited
7. **Performance modelling of communication networks**

**Recommended Text:**

1. Thomas Robertazzi, Computer Networks and Systems: Queuing theory and Performance Evaluation, Springer-Verlag, 2000
2. B.R. Hverkort, Performance of Computer Communication systems (A model based approach), Wiley, 1998

and more.

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| Title of the Course | | Functional Analysis | | | | | | | | |
| Paper Number | | CORE XI | | | | | | | | |
| **Category** | Core | Year | II | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | IV | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | Elements of Real Analysis | | | | | | | | |
| **Objectives of the Course** | | 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. | | | | | | | | |
| **Course Outline** | | **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– Involutions in Banach algebras-The Gelfand-Neumark theorem.  **Chapter 13:Sections 70-73** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | 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. | | | | | | | | |
| **Website and**  **e-Learning Source** | | [http://mathforum.org](http://www.mathforum.org), <http://ocw.mit.edu/ocwweb/Mathematics>,  <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.

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|  | POs | | | | | | PSOs | | |
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| 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 |

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| Title of the Course | | DIFFERENTIAL GEOMETRY | | | | | | | | |
| Paper Number | | CORE XII | | | | | | | | |
| **Category** | Core | Year | II | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | IV | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | | 1 | | -- | | | 5 | |
| **Pre-requisite** | | Linear Algebra concepts and Calculus | | | | | | | | |
| **Objectives of the Course** | | 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 | | | | | | | | |
| **Course Outline** | | **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 with curves 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).** | | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | | |
| Skills acquired from this course | | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | | | | | | | | |
| **Recommended Text** | | T.J.Willmore, *An Introduction to Differential Geometry,* Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print) | | | | | | | | |
| RefereEce Books | | * + - 1. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison – Wesley, Mass. 1950.       2. Kobayashi. S. and Nomizu. K.  *Foundations of Differential Geometry,* Inter science Publishers, 1963.       3. Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts 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://www.mathforum.org), <http://ocw.mit.edu/ocwweb/Mathematics>,  <http://www.opensource.org>, [www.physicsforum.com](http://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, fundamental form 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

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|  | 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 |

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| Title of the Course | | PROJECT WITH VIVA VOCE | | | | | | | | |
| Paper Number | |  | | | | | | | | |
| **Category** | Core | Year | II | | **Credits** | | 4 | **Course Code** | |  |
| **Semester** | IV | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | | **Total** | |
| 4 | |  | | -- | | | 5 | |
| **Pre-requisite** | | UG Level Mathematics | | | | | | | | |