# M Sc MATHEMATICS

LOCF SYLLABUS 2025


**Department of Mathematics**

School of Computing Sciences

St. Joseph's College (Autonomous)

Tiruchirappalli - 620002, Tamil Nadu, India

**SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS) POSTGRADUATE COURSES**

St. Joseph's College (Autonomous), an esteemed institution in the realm of higher education in India, has embarked on a journey to uphold and perpetuate academic excellence. One of the pivotal initiatives in this pursuit is the establishment of five Schools of Excellence commencing from the academic year 2014-15. These schools are strategically designed to confront and surpass the challenges of the 21st century.

Each School amalgamates correlated disciplines under a unified umbrella, fostering synergy and coherence. This integrated approach fosters the optimal utilization of both human expertise and infrastructure. Moreover, it facilitates academic fluidity and augments employability by nurturing a dynamic environment conducive to learning and innovation. Importantly, while promoting collaboration and interdisciplinary study, the Schools of Excellence also uphold the individual identity, autonomy, and distinctiveness of every department within.

The overarching objectives of these five schools are as follows:

1. Optimal Resource Utilization: Ensuring the efficient use of both human and material resources to foster academic flexibility and attain excellence across disciplines.

2. Horizontal Mobility for Students: Providing students with the freedom to choose courses aligning with their interests and facilitating credit transfers, thereby enhancing their academic mobility and enriching their learning experience.

3. Credit-Transfer Across Disciplines (CTAD): The existing curricular structure, compliant with regulations from entities such as TANSCHE and other higher educational institutions, facilitates seamless credit transfers across diverse disciplines. This underscores the adaptability and uniqueness of the choice-based credit system.

4. Promotion of Human Excellence: Nurturing excellence in specialized areas through focused attention and resources, thus empowering individuals to excel in their respective fields.

5. Emphasis on Internships and Projects: Encouraging students to engage in internships and projects, serving as stepping stones toward research endeavors, thereby fostering a culture of inquiry and innovation.

6. Addressing Stakeholder Needs: The multi-disciplinary nature of the School System is tailored to meet the requirements of various stakeholders, particularly employers, by equipping students with versatile skills and competencies essential for success in the contemporary professional landscape.

In essence, the Schools of Excellence at St. Joseph's College (Autonomous) epitomize a holistic approach towards education, aiming not only to impart knowledge but also to cultivate critical thinking, creativity, and adaptability – qualities indispensable for thriving in the dynamic global arena of the 21st century.

**Credit system**

The credit system at St. Joseph's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines.

The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work.

For postgraduate (PG) courses, students are required to accumulate a minimum of 92 credits, as stipulated in the programme pattern table. The total minimum number of courses offered by the department is outlined in the Programme Structure.

**OUTCOME-BASED EDUCATION (OBE)**

OBE is an educational approach that revolves around clearly defined goals or outcomes for every aspect of the educational system. The primary aim is for each student to successfully achieve these predetermined outcomes by the culmination of their educational journey. Unlike traditional methods, OBE does not

prescribe a singular teaching style or assessment format. Instead, classes, activities, and evaluations are structured to support students in attaining the specified outcomes effectively.

In OBE, the emphasis lies on measurable outcomes, allowing educational institutions to establish their own set of objectives tailored to their unique context and priorities. The overarching objective of OBE is to establish a direct link between education and employability, ensuring that students acquire the necessary skills and competencies sought after by employers.

OBE fosters a student-centric approach to teaching and learning, where the delivery of courses and assessments are meticulously planned to align with the predetermined objectives and outcomes. It places significant emphasis on evaluating student performance at various levels to gauge their progress and proficiency in meeting the desired outcomes.

Here are some key aspects of Outcome-Based Education:

*Course:* A course refers to a theory, practical, or a combination of both that is done within a semester.

*Course Outcomes (COs):* These are statements that delineate the significant and essential learning outcomes that learners should have achieved and can reliably demonstrate by the conclusion of a course. Typically, three or more course outcomes are specified for each course, depending on its importance.

*Programme:* This term pertains to the specialization or discipline of a degree programme.

*Programme Outcomes (POs):* POs are statements that articulate what students are expected to be capable of by the time they graduate. These outcomes are closely aligned with Graduate Attributes.

*Programme Specific Outcomes (PSOs):* PSOs outline the specific skills and abilities that students should possess upon graduation within a particular discipline or specialization.

*Programme Educational Objectives (PEOs):* PEOs encapsulate the expected accomplishments of graduates in their careers, particularly highlighting what they are expected to achieve and perform during the initial years postgraduation.

**LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)**

The Learning Outcomes-Centric Framework (LOCF) places the learning outcomes at the forefront of curriculum design and execution. It underscores the importance of ensuring that these outcomes are clear, measurable, and relevant. LOCF orchestrates teaching methodologies, evaluations, and activities in direct correlation with these outcomes. Furthermore, LOCF adopts a backward design approach, focusing on defining precise and attainable learning objectives. The goal is to create a cohesive framework where every educational element is in harmony with these outcomes.

Assessment practices within LOCF are intricately linked to the established learning objectives. Evaluations are crafted to gauge students' achievement of these outcomes accurately. Emphasis is often placed on employing authentic assessment methods, allowing students to showcase their learning in real-life scenarios. Additionally, LOCF frameworks emphasize flexibility and adaptability, enabling educators to tailor curriculum and instructional approaches to suit the diverse needs of students while ensuring alignment with the defined learning outcomes.

**Some important terminologies**

***Core Courses (CC):*** *These are compulsory courses that students must undertake as essential components of their curriculum, providing fundamental knowledge within their primary discipline. Including core courses is essential to maintain a standardized academic programme, ensuring recognition and consistency across institutions.*

***Discipline Specific Elective Courses (ES):*** *Elective courses are offered within the main discipline or subject of study. They allow students to select specialized or advanced options from a range of courses, offering in-depth exposure to their chosen area of study. Typically, ES are more applied in nature and provide a deeper understanding of specific topics.*

***Research Methodology (RM)****: It is a two-credit course offered in the third semester as a common program across disciplines within the school. It is designed to cultivate a strong research aptitude among postgraduate students. The course equips learners with essential skills for formulating research problems and pursuing impactful research.*

***Open Elective Courses (OE):*** *These elective courses are chosen from disciplines unrelated to the student's main area of study, aiming to broaden their exposure and knowledge base. As per the Choice Based Credit System (CBCS) policy, students may opt for Open elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

***Ability Enhancement Course (AEC):*** *AE is designed to enhance skills and proficiencies related to the student's main discipline. It aims to provide practical training and hands-on experience, contributing to the overall development of students pursuing academic programmes.*

***Skill Enhancement Course (SEC):*** *SE focus on developing specific skills or proficiencies relevant to students' academic pursuits. While it is open to students from any discipline, SE is particularly beneficial for those within the related academic programme.*

***Self-Learning (SL):*** *A two-credit course designed to foster students' ability for independent and self-directed learning. There are* Three Self-Learning Courses:

- 'Global Citizenship Education' *a common online course offered to all PG students in Semester I on JosTEL.*
- *Compulsory MOOC on NPTEL-SWAYAM in Semester I or II*
- *A Department-Specific Self-Learning Course in Semester III on JosTEL*

***Comprehensive Examination (CE):*** *These examinations cover detailed syllabi comprising select units from courses offered throughout the programme. They are designed to assess crucial knowledge and content that may not have been covered extensively in regular coursework.*

***Extra Credit Courses:*** *To support students in acquiring knowledge and skills through online platforms such as Massive Open Online Courses (MOOCs), additional credits are granted upon verification of course completion. These extra credits can be availed across three semesters (1 - 4). In line with UGC guidelines, students are encouraged to enhance their learning by enrolling in MOOCs offered by portals like SWAYAM, NPTEL, and others. Additionally, certificate courses provided by the college are also considered for these extra credits.*

***Outreach Programme (OR):*** *It is a compulsory course to create a sense of social concern among all the students and to inspire them to dedicated service to the needy.*

**Course Coding**

The following code system (10 alphanumeric characters) is adopted for Postgraduate courses:

| **25** | **UXX** | **0** | **XX** | **00/X** |
|---|---|---|---|---|
| Year of Revision | PG Department Code | Semester Number | Course Specific Initials | Running Number/with Choice |

**Course Specific Initials**

*CC - Core Course*

*CP - Core Practical*

*ES - Discipline Specific Elective*

*AE - Ability Enhancement Course*

*SL - Self-Learning*

*OE – Open Elective*

*PW - Project and Viva Voce*

*CE - Comprehensive Examination*

*OR - Outreach Programme*

*IS – Internship*

*RM – Research Methodology*

## EVALUATION PATTERN (PG)

### Continuous Internal Assessment

| Sl No | Component | Marks Allotted |
|---|---|---|
| 1 | Mid Semester Test | 30 |
| 2 | End Semester Test | 30 |
| 3 | *Two Components (15 + 20) | 35 |
| 4 | Library Referencing | 5 |
| | **Total** | **100** |

*Passing minimum: 50 marks*

* *The first component is a compulsory online test (JosTEL platform) for 15 marks comprising 7 questions (1 mark) at K1 level and 4 questions (2 marks) at K2 level;* The second component is decided by the course in-charge in accordance with the prescribed K levels.

### Question Paper Blueprint for Mid and End Semester Tests

| **Duration: 2 Hours** | | | | | | | | **Maximum Marks: 60** |
|---|---|---|---|---|---|---|---|---|
| **Section** | | **K levels** | | | | | | **Marks** |
| | | **K1** | **K2** | **K3** | **K4** | **K5** | **K6** | |
| **A** *(compulsory)* | | 7 | | | | | | 7 × 1 = 7 |
| **B** *(compulsory)* | | | 5 | | | | | 5 × 3 = 15 |
| **C** *(either…or type)* | | | | 3 | | | | 3 × 6 = 18 |
| **D** *(2 out of 3)* | Mid Sem | | | | 1(2) | 1* | | 2 × 10 = 20 |
| | End Sem | | | | | 1(2) | 1* | |
| | | | | | | | **Total** | **60** |

***** *Compulsory*

### Question Paper Blueprint for Semester Examination

| **Duration: 3 Hours** | | | | | | | **Maximum Marks: 100** |
|---|---|---|---|---|---|---|---|
| **Section** | **K levels** | | | | | | **Marks** |
| | **K1** | **K2** | **K3** | **K4** | **K5** | **K6** | |
| **A** *(compulsory)* | 10 | | | | | | 10 × 1 = 10 |
| **B** *(compulsory)* | | 10 | | | | | 10 × 3 = 30 |
| **C** *(either…or type)* | | | 5 | | | | 5 × 6 = 30 |
| **D** *(3 out of 5)* | | | | 1(2) | 1(2) | 1* | 3 × 10 = 30 |
| | | | | | | **Total** | **100** |

***** *Compulsory*

**Evaluation Pattern for One/Two-credit Courses**

| Title of the Course | CIA | Semester Examination | Final |
|---|---|---|---|
| • Ability Enhancement Course | 20 + 10 + 20 = 50 | 50 *(Department)* | 100 |
| • Self - Learning Course (Dept. Specific)<br>• Comprehensive Examination | 25 + 25 = 50 | 50 *(CoE)* | 100 |
| • Internship<br>• Self - Learning Course (Common)<br>• Self - Learning Online Course (NPTEL / SWAYAM) | 100 | - | 100 |
| • Skill Enhancement Course: Soft Skills | 100 | - | 100 |
| • Project Work and Viva Voce | 100 | 100 | 100 |

**Grading System**

The marks obtained in the CIA and semester for each course will be graded as per the scheme provided in Table - 1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), respectively. These two are calculated by the following formulae:

$$SGPA \ and \ CGPA = \frac{\sum_{i=1}^{n} C_i Gp_i}{\sum_{i=1}^{n} C_i}$$

$$WAM = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$$

*Where,*

*Ci - credit earned for the Course i*

*Gpi - Grade Point obtained for the Course i*

*Mi - Marks obtained for the Course i*

*n - Number of Courses **passed** in that semester*

*WAM - Weighted Average Marks*

**Table - 1: Grading of the Courses for PG**

| Mark Range | Grade Point | Corresponding Grade |
|---|---|---|
| 90 and above | 10 | O |
| 80 and above and below 90 | 9 | A+ |
| 70 and above and below 80 | 8 | A |
| 60 and above and below 70 | 7 | B+ |
| 50 and above and below 60 | 6 | B |
| Below 50 | 0 | RA |

**Table - 2: Grading of the Final Performance for PG**

| CGPA | Grade | Performance |
|---|---|---|
| 9.00 and above | O | Outstanding* |
| 8.00 to 8.99 | A+ | Excellent* |
| 7.00 to 7.99 | A | Very Good |
| 6.00 to 6.99 | B+ | Good |
| 5.00 to 5.99 | B | Above Average |
| Below 5.00 | RA | Re-appear |

**The Candidates who have passed in the first appearance and within the prescribed duration of the PG programme are eligible. If the Candidates Grade is O/A+ with more than one attempt, the performance is considered "Very Good".*

## Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

## Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value- driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

## Programme Educational Objectives (PEOs)

1. Graduates will be able to accomplish professional standards in the global environment.
2. Graduates will be able to uphold integrity and human values.
3. Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

## Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

## Programme Specific Outcomes (PSOs)

Graduate will be able to

1. Appreciate the emphasis given on teaching the fundamentals, the basic concepts, definitions with a variety of examples.
2. Realise the importance given to applications by applying the concepts studied for designing models to solve real life problems.
3. Develop the skill to solve problems which appear in the various examinations based on the concepts learned which in turn will hone the problem solving skills of students and help them to pass competitive examinations including CSIR-NET, SET, IAS, etc
4. Learn application oriented subjects which will impress upon them their responsibility to the society.
5. Get proper orientation that a research degree is not end of learning. They are encouraged to publish papers on a continual basis in the standard journals during and after Ph.D.

| M. Sc. Mathematics | | | | |
|---|---|---|---|---|
| **Programme Structure** | | | | |
| **Semester** | **Specification** | **No. of Courses** | **Hours** | **Credits** |
| 1 – 4 | Core Course | 15 | 82 | 61 |
| 1 - 4 | Core Practical | - | - | - |
| 1, 3 & 4 | Discipline Specific Elective | 3 | 12 | 9 |
| 1 – 2 | Open Elective | 2 | 8 | 4 |
| 1 | Ability Enhancement Course | 1 | 2 | 1 |
| 1 – 3 | Self-Learning | 3 | - | 4 |
| 2 | Skill Enhancement Course | 1 | 4 | 2 |
| 3 | Research Methodology | 1 | 4 | 2 |
| 4 | Project | 1 | 8 | 3 |
| 4 | Comprehensive Examination | 1 | - | 2 |
| 2 – 4 | Outreach Programme (SHEPHERD) | - | - | 4 |
| 1 – 4 | Extra Credit Course | 4 | - | 12 |
| | **Total** | **32** | **120** | **92 (12)** |

| M Sc MATHEMATICS PROGRAMME PATTERN | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Course Details | | | | | | Scheme of Exams | | |
| **Sem.** | **Course Code** | **Course Type** | **Title of the Course** | **Hours** | **Credits** | **CIA** | **SE** | **Final** |
| 1 | 25PMA1CC01 | **CC Major** | **Core Course - 1:** Algebraic Structures | 5 | 4 | 100 | 100 | 100 |
| | 25PMA1CC02 | | **Core Course - 2:** Real Analysis - 1 | 5 | 4 | 100 | 100 | 100 |
| | 25PMA1CC03 | | **Core Course - 3:** Ordinary Differential Equations | 5 | 4 | 100 | 100 | 100 |
| | 25PMA1CC04 | | **Core Course - 4:** Graph Theory and its Applications | 5 | 3 | 100 | 100 | 100 |
| | 25PMA1ES01A | **DSE** | **Discipline Specific Elective - 1:** Stochastic Processes | 4 | 3 | 100 | 100 | 100 |
| | 25PMA1ES01B | | **Discipline Specific Elective - 1:** Differential Geometry | | | | | |
| | 25PMA1AE01 | **AEC** | **Ability Enhancement Course:** Problem Solving in Advanced Mathematics | 2 | 1 | 100 | - | 100 |
| | 25PMA1OE01 | **OE** | **Open Elective – 1 (WS):** Mathematical Foundations | 4 | 2 | 100 | 100 | 100 |
| | 25PGC1SL01 | **SL** | Global Citizenship Education (Online) | 0 | 1 | 100 | - | 100 |
| | | | Extra Credit Course | 0 | (3) | | | |
| | | | **Total** | **30** | **22 (3)** | | | |
| 2 | 25PMA2CC05 | **CC Major** | **Core Course - 5:** Advanced Algebra | 6 | 4 | 100 | 100 | 100 |
| | 25PMA2CC06 | | **Core Course - 6:** Real Analysis - 2 | 5 | 4 | 100 | 100 | 100 |
| | 25PMA2CC07 | | **Core Course - 7:** Complex Analysis | 6 | 4 | 100 | 100 | 100 |
| | 25PMA2CC08 | | **Core Course - 8:** Internship Embedded Course: Mathematical Modelling | 5 | 4 | 100 | 100 | 100 |
| | 25PMA2OE02 | **OE** | **Open Elective – 2 (BS):** Operations Research | 4 | 2 | 100 | 100 | 100 |
| | 25PSS2SE01 | **SEC** | **Skill Enhancement Course:** Soft Skills | 4 | 2 | 100 | - | 100 |
| | 25PMA2SL02 | **SL** | Online Courses: NPTEL / SWAYAM | 0 | 2 | - | 100 | 100 |
| | | | Extra Credit Course | 0 | (3) | | | |
| | | | **Total** | **30** | **22 (3)** | | | |
| 3 | 25PMA3CC09 | **CC Major** | **Core Course - 9:** Topology | 6 | 5 | 100 | 100 | 100 |
| | 25PMA3CC10 | | **Core Course - 10:** Measure and Integration | 6 | 5 | 100 | 100 | 100 |
| | 25PMA3CC11 | | **Core Course - 11:** Classical Dynamics | 5 | 3 | 100 | 100 | 100 |
| | 25PMA3CC12 | | **Core Course - 12:** Algebraic Number Theory | 5 | 3 | 100 | 100 | 100 |
| | 25PMA3ES02A | **DSE** | **Discipline Specific Elective - 2:** Numerical Analysis | 4 | 3 | 100 | 100 | 100 |
| | 25PMA3ES02B | | **Discipline Specific Elective - 2:** Optimization Techniques | | | | | |
| | 25SCS3RM01 | **RM** | Research Methodology | 4 | 2 | 100 | 100 | 100 |
| | 25PMA3SL03 | **SL** | **Self-Learning:** History of Mathematics* | 0 | 1 | 50 | 50 | 50 |
| | | | Extra Credit Course | 0 | (3) | | | |
| | | | **Total** | **30** | **22 (3)** | | | |
| 4 | 25PMA4CC13 | **CC Major** | **Core Course -13:** Functional Analysis | 6 | 5 | 100 | 100 | 100 |
| | 25PMA4CC14 | | **Core Course - 14:** Calculus of Variations and Integral Equations | 6 | 4 | 100 | 100 | 100 |
| | 25PMA4CC15 | | **Core Course -15:** Partial Differential Equations | 6 | 4 | 100 | 100 | 100 |
| | 25PMA4ES03A | **DSE** | **Discipline Specific Elective - 3:** Automata Theory | 4 | 3 | 100 | 100 | 100 |
| | 25PMA4ES03B | | **Discipline Specific Elective - 3:** Programming in C++ | | | | | |
| | 25PMA4PW01 | **PW** | Project | 8 | 4 | 100 | 100 | 100 |
| | 25PMA4CE01 | **CE** | Comprehensive Examination* | 0 | 2 | 50 | 50 | 50 |
| | | | Extra Credit Course | 0 | (3) | | | |
| | | | **Total** | **30** | **22 (3)** | | | |
| | 25PCW4OR01 | **OR** | Outreach Programme | 0 | 4 | | | |
| 1-4 | | | **TOTAL** | **120** | **92 (12)** | | | |

***For Grade Calculation:** Marks obtained out of 50 will be converted into 100 in the mark statements.

## Open Elective - 1 (WS): 1st Semester

| School | Course Code | Title of the Course |
|---|---|---|
| **SCS** | | |
| Artificial Intelligence | 25PAI1OE01 | Neural Networks and Fuzzy Logic |
| Computer Science | 25PCA1OE01A | AI Tools & Applications |
| | 25PCA1OE01B | Internet of Things |
| Information Technology | 25PCS1OE01 | Big Data Analytics |
| Data Science | 25PDS1OE01 | SQL and NoSQL for Data Science |
| Mathematics | 25PMA1OE01 | Mathematical Foundations |

## Open Elective – 2 (BS): 2nd Semester
## Offered to students from other Schools

| School | Course Code | Title of the Course |
|---|---|---|
| **SBS** | | |
| Botany | 25PBO2OE02 | Sustainable Horticulture and Urban Landscaping |
| Biochemistry | 25PBI2OE02 | First Aid Management |
| Biotechnology | 25PBT2OE02 | Food Technology |
| **SCS** | | |
| Artificial Intelligence and Machine Learning | 25PAI2OE02 | Cyber Security |
| Computer Science | 25PCA2OE02A | Web Design |
| | 25PCA2OE02B | Cyber Security |
| Information Technology | 25PCS2OE02 | Recent Trends in Computing |
| Data Science | 25PDS2OE02 | Discrete Mathematics |
| Mathematics | 25PMA2OE02 | Operations Research |
| Visual Communication | 25PVC2OE02 | Women and Media |
| **SLAC** | | |
| English | 25PEN2OE02 | English for Digital Media |
| History | 25PHS2OE02 | Public Administration |
| Tamil | 25PTA2OE02 | விளம்பரக்கலை (Art of advertising) |
| **SMS** | | |
| Commerce | 25PCO2OE02 | Basics of Tally Prime |
| Commerce Computer Application | 25PCC2OE02 | Behavioural Dynamics and Psychology |
| Counselling Psychology | 25PCP2OE02 | Artificial Intelligence in Psychology |
| Economics | 25PEC2OE02 | Managerial Economics |
| Human Resource Management | 25PHR2OE02 | Counselling and Guidance |
| **SPS** | | |
| Chemistry | 25PCH2OE02 | Chemistry of Health and Nutrition |
| Electronics | 25PEL2OE02 | Computer Hardware and Networks |
| Physics | 25PPH2OE02A | Physics for Competitive Exams |
| | 25PPH2OE02B | Nanoscience |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 1 | 25PMA1CC01 | **Core Course - 1:** Algebraic Structures | 5 | 4 |

| Course Objectives |
|---|
| To gain a deep understanding of important concepts of class equations and Sylow's theorem in group theory and develop proficiency in their applications. |
| To investigate the structure and behavior of algebraic systems and classify them based on certain properties, and apply the concepts to solve various mathematical problems in diverse area of studies. |
| To understand the concepts of linear transformations and their properties, simplifying their representation, and analyzing their behaviors in various mathematical contexts. |
| To simplify matrix representations while the rational canonical form aims to classify matrices, study minimal polynomials, and compute matrix powers efficiently. |
| To provide insights into Eigenvalues and Eigenvectors. |

**UNIT I** **(15 Hours)**

Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, second proof only).

**UNIT II** **(15 Hours)**

Direct products - Finite abelian groups- Modules.

**UNIT III** **(15 Hours)**

Linear Transformations: Canonical forms -Triangular form - Nilpotent transformations.

**UNIT IV** **(15 Hours)**

Jordan form - rational canonical form.

**UNIT V** **(15 Hours)**

Trace and transpose - Hermitian, unitary, normal transformations.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, Lectures, Demonstrations, PPT. |
| **Assessment Methods** | MCQ, Quiz & Snap Test |

**Books for Study:**

1. Herstein, I.N. (1975), *Topics in Algebra,* (2nd Ed.). Wiley Eastern Limited, New Delhi.
   - **Unit I :** Chapter 2: Sections 2.11 and 2.12 (Omit Lemma 2.12.5)
   - **Unit II :**Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only)
     Chapter 4: Section 4.5
   - **Unit III :** Chapter 6: Sections 6.4, 6.5
   - **Unit IV :** Chapter 6 : Sections 6.6 and 6.7
   - **Unit V :** Chapter 6 : Sections 6.8, 6.10

**Books for Reference:**


1. Artin, M. (1991). *Algebra.* Prentice Hall of India.
2. Bhattacharya, P. B., Jain, S.K., & Nagpaul, S.R. (1997). *Basic Abstract Algebra*, (2nd Ed.). Cambridge University Press (Indian Edition).
3. Luther, S., & Passi, I.B.S. (1999). *Algebra, Vol. I -Groups (1996); Vol. II Rings*, Narosa Publishing House, New Delhi.
4. Malik, D. S., Mordeson, J.N., &Sen, M.K. (1997). *Fundamental of Abstract Algebra*. McGraw Hill (International Edition), New York.
5. Jacobson, N. (1980). *Basic Algebra, Vol. I & II W. H. Freeman.* published by Hindustan Publishing Company, New Delhi.


**Website and e-Learning Source:**

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

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K - Levels)** |
| **CO1** | Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups. | **K1** |
| **CO2** | Define direct products, examine the properties of finite abelian groups, define modules | **K2** |
| **CO3** | 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. | **K3** |
| **CO4** | 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. | **K4** |
| **CO5** | 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 | **K5** |
| **CO6** | Interpret and evaluate ideas of theory of Eigen values. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **1** | **25PMA1CC01** | | | **Core Course - 1:** Algebraic Structures | | | | | | **5** | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | **2.5** |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | **2.3** |
| **CO3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | **2.3** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | **2.6** |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO6** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| | | | | | | | | | | **Mean Overall Score** | **2.42(High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 1 | 25PMA1CC02 | **Core Course - 2:** Real Analysis - 1 | 5 | 4 |

| Course Objectives |
|---|
| To enable the students to learn the basic concepts of real analysis. |
| To understand proof techniques in analysis and be well prepared for the advanced courses like functional analysis and advanced analysis |
| To work comfortably with metric spaces and its applications |
| To work with Convergence of sequences and series |
| To know continuity and differentiability of the real functions |

**UNIT I** **(15 Hours)**

Introduction - Ordered sets - Finite, Countable and Uncountable Sets - Metric Spaces

**UNIT II** **(15 Hours)**

Compact Sets - Perfect Sets - Connected Sets - Convergent Sequences - Subsequences

**UNIT III** **(15 Hours)**

Cauchy Sequences - Upper and Lower Limits - some Special sequences - Series - Series of non-negative terms - The Root and Ratio Tests - Power Series - Summation by parts.

**UNIT IV** **(15 Hours)**

Continuous functions - Continuity and compactness continuity and Connectedness - Discontinuities

**UNIT V** **(15 Hours)**

The Derivative of a Real Functions - Mean Value Theorems - The Continuity of Derivatives - L' Hospital's Rule - Derivative of Higher Order - Taylor's Theorem.

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk method, Problem solving, Snap Test |
| **Assessment Methods** | Snap test, Seminar, MCQ |

**Books for Study:**

1. Rudin, W. (1976). *Principles of Mathematical Analysis*, (3rd Ed.). McGraw Hill Company, New York.
   **Unit- I** *Chapter 1(Sec 1.0- 1.11) and Chapter 2 (2.0-2.30)*
   **Unit- II** *Chapter 2 (Sec 2.31- 2.47) and Chapter 3 (3.1-3.7)*
   **Unit- III** *Chapter 3 (3.8-3.29 and 3.35-3.44)*
   **Unit- IV** *Chapter 4 (Sec 4.5-4.27)*
   **Unit- V** *Chapter 5 (Sec 5.0-5.15)*

**Books for Reference:**


1. Bartle, R.G. (1976). *Real Analysis*, John Wiley and Sons Inc.
2. Apostol, T.M. (1974). *Mathematical Analysis*, (2nd Ed.). Addison-Wesley Publishing Company Inc. New York.
3. Richard R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Company, New Delhi, 1970.


**Website and e-Learning Source:**

1. https://math.mit.edu/~djk/calculus_beginners/chapter16/section02.html
2. https://brilliant.org/wiki/cauchy-sequences/
3. https://ece.iisc.ac.in/~parimal/2015/proofs/lecture-17.pdf

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K - Levels)** |
| **CO1** | Acquire knowledge of concepts of modern analysis such as Ordered sets, countable sets and metric spaces. | **K1** |
| **CO2** | Understand the concepts of Compact sets, Perfect sets, connected sets, Sequences, Subsequence | **K2** |
| **CO3** | Apply the suitable tests to examine the convergent and divergent series. | **K3** |
| **CO4** | Analyze the properties of sets of real numbers (such as countable set and uncountable sets), sequence of real numbers, convergence, Cauchy's sequence limit theorem (such as monotone convergence theorem), the basic results associated with the continuity and differentiability of real valued functions | **K4** |
| **CO5** | Evaluate the limits of functions, derivative of functions at a point and points of discontinuity. | **K5** |
| **CO6** | Construct proofs and examples of metric spaces, convergence, continuous functions and differential functions. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **1** | **25PMA1CC02** | | | **Core Course - 2:** Real Analysis - 1 | | | | | | **5** | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | **2.7** |
| **CO2** | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | **2.6** |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | **2.8** |
| **CO4** | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | **2.7** |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | **2.9** |
| **CO6** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | **2.6** |
| **Mean Overall Score** | | | | | | | | | | | **2.7 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 1 | 25PMA1CC03 | **Core Course - 3:** Ordinary Differential Equations | 5 | 4 |

| Course Objectives |
|---|
| Enhance proficiency in solving homogeneous and non-homogeneous linear differential equations with constant and variable coefficients. |
| Enlighten on the theoretical foundations of differential equations, such as linear independence, Wronskian, existence and uniqueness of solutions. |
| Acquaint on recognizing different types of linear differential equations and apply the appropriate solution methods. |
| Enlighten to translate real-world problems into mathematical models using linear differential equations and interpret the solutions in the context of the original problem. |
| Enhance analytical and problem-solving abilities to approach and solve diverse problems related to linear differential equations. |

**UNIT I: Second order linear equations with constant coefficients (15 Hours)**

The second order homogeneous equation - Initial value problems - Linear dependence and independence - A formula for the Wronskian -The non-homogeneous equation of order two.

**UNIT II: n-th order linear equations with constant coefficients (15 Hours)**

The homogeneous equation of order n - Initial value problems -Equations with real constants - The non-homogeneous equation of order n - Annihilator method for solving the non-homogeneous equation.

**UNIT III: Linear equations with variable coefficients (15 Hours)**

Initial value problems and solutions of the homogeneous equation -The Wronskian and linear dependence - Reduction of the order of a homogeneous equation -The non-homogeneous equation - Homogeneous equation with analytic coefficients - The Legendre equation.

**UNIT IV: Linear equations with regular singular points (15 Hours)**

The Euler equation - Second order equations with regular singular points -The Bessel equation.

**UNIT V: Existence and uniqueness of solutions to first order equations (15 Hours)**

Equations with variables separated - Exact equations -The method of successive approximations - The Lipschitz condition - Convergence of the successive approximations.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, Lectures, Demonstrations, PPT. |
| **Assessment Methods** | Seminar, Web based Assignments, Snap test/MCQ test |

**Books for Study:**

1. Coddington, E.A. (2019). *An introduction to ordinary differential equations,* (3rd Printing) Prentice-Hall of India Ltd., New Delhi.

   **Unit -I**: Chapter 2: Sections 1 to 6
   **Unit -II:** Chapter 2: Sections 7 to 11
   (Omit proof of theorem 19 in Section 9; In Section 11, problems only)
   **Unit -III:** Chapter: 3 Sections 1 to 8
   (Omit proof of theorem 9 in Section 5; Omit theorem 12 in Section 7)
   **Unit -IV:** Chapter 4: Sections 1 to 4 and 7, 8
   **Unit -V:** Chapter 5: Sections 1 to 6

**Books for Reference:**


1. Boyce, W.E., & Prima, R.D.CI. (1967). *Elementary differential equations and boundary value problems*. John Wiley and sons, New York.
2. Simmons, G.F. (1974). *Differential equations with applications and historical notes.* Tata McGraw Hill, New Delhi.

3. Lebedev, N.N. (1965). *Special functions and their applications*, Prentice Hall of India, New Delhi.
4. Reid, W.T. (1971). *Ordinary Differential Equations*. John Wiley and Sons, New York.
5. Raisinghania, M.D. (2001). *Advanced Differential Equations*. S. Chand & Company Ltd. New Delhi.
6. Rai, B., Choudary, D.P., & Freedman, H.I. (2002). *A Course in Ordinary Differential Equations*, Narosa Publishing House, New Delhi.

**Website and eLearning Source:**

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

| **Course Outcomes** | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K - Levels)** |
| **CO1** | Solve second and higher-order linear homogeneous and non-homogeneous differential equations with constant coefficients. | **K1** |
| **CO2** | Analyze the linear dependence and independence of solutions using the Wronskian and apply it to solve initial value problems. | **K2** |
| **CO3** | Solve linear differential equations with variable coefficients using appropriate methods, including reduction of order and series solutions. | **K3** |
| **CO4** | Determine solutions to linear differential equations with regular singular points using the Euler equation and series solutions, including Bessel's equation. | **K4** |
| **CO5** | Apply methods for solving first-order differential equations, including separation of variables, exact equations, and successive approximations, and demonstrate understanding of existence and uniqueness theorems. | **K5** |
| **CO6** | Model and solve real-world problems using linear differential equations, demonstrating analytical and problem-solving skills. | **K6** |

| **Relationship Matrix** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credits** | |
| **1** | **25PMA1CC03** | | | **Core Course - 3:** Ordinary Differential Equations | | | | **5** | | **4** | |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | **2.8** |
| **CO2** | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | **2.6** |
| **CO3** | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **2.8** |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | **2.8** |
| **CO5** | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | **2.5** |
| **CO6** | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **2.8** |
| | | | | | | | | | | **Mean Overall Score** | **2.7 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 1 | 25PMA1CC04 | **Core Course - 4:** Graph Theory and its Applications | 5 | 3 |

| Course Objectives |
|---|
| To introduce the basic concepts of graphs and digraphs. |
| To introduce the notion of connectivity in graphs and the concept of trees. |
| To familiarize on the ideas of independent sets, coverings, matchings and factors. |
| To acquaint on Eulerian, Hamiltonian and planar graphs and the concept of graph colorings, and the notion of duality in graphs. |
| To develop the skill of formulating real life problems to graphical models and finding solutions. |

**UNIT I: Graphs and Digraphs (15 Hours)**

Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness - Operations on Graphs - Directed Graphs: Basic Concepts.

**UNIT II: Connectivity and Trees (15 Hours)**

Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity - Trees: Definition, Characterization and Simple Properties

**UNIT III: Independent set, Eulerian and Hamiltonian graphs (15 Hours)**

Vertex Independent Sets and Vertex Coverings - Edge Independent Sets - Matching's and Factors - Eulerian Graphs - Hamiltonian Graphs.

**UNIT IV: Colouring of Graphs (15 Hours)**

Vertex Colorings - Applications of Graph Coloring - Critical Graphs - Edge Colorings of Graphs.

**UNIT V: Planar Graphs (15 Hours)**

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 the Heawood Five-Color Theorem.

**Note: Theorems, propositions and results which are starred in the book are to be omitted.**

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, PPT, Mathematical Models, Videos |
| **Assessment Methods** | Seminar, Snap Test, MCQ, Assignment |

**Books for Study:**

1. Balakrishnan, R. & Ranganathan, K. (2019). A Textbook of Graph Theory (Second Edition), Springer (India) Private Limited, New Delhi.
   Unit-I : Chapter I: 1.1 - 1.5, 1.8, Chapter II: 2.1- 2.2
   Unit-II : Chapter III: 3.1- 3.3,Chapter IV: 4.1-4.2
   Unit-III : Chapter V: 5.1 - 5.4, Chapter VI: 6.1- 6.2
   Unit-IV : Chapter VII: 7.1-7.3(omit 7.3.2, 7.3.3.)
   Unit-V : Chapter VIII: 8.1 to 8.6

**Books for Reference:**


1. Bondy, J. A., Murty, U. S. R. (1976). Graph Theory with Applications. Macmillan Press Ltd.
2. Harary, F. (1969). Graph Theory. Addison - Wesley Publishing Company, Inc.
3. Chartrand, G., Lesniak, L., & Zhang, P. (2010). Graphs and Digraphs. CRC press.


**Websites and eLearning Sources:**

1. https://onlinecourses.nptel.ac.in/noc20_ma05/preview
2. https://onlinecourses.swayam2.ac.in/cec20_ma03/preview

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Acquire in-depth knowledge on vital concepts in graph theory. | **K1** |
| **CO2** | Understand the graphs, its types and on the theory of connectivity, colorings and planarity. | **K2** |
| **CO3** | Apply the imbibed knowledge on the concepts to categorize graphs. | **K3** |
| **CO4** | Analyse and infer properties of graphs and its associated concepts. | **K4** |
| **CO5** | Evaluate various parameters of a graph. | **K5** |
| **CO6** | Construct graphs with specific properties. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | **Title of the Course** | | | | | | | **Hours** | **Credits** |
| **1** | **25PMA1CC04** | | **Core Course - 4:** Graph Theory and its Applications | | | | | | | **5** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | **2.5** |
| **CO2** | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | **2.4** |
| **CO3** | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.4** |
| **CO4** | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | **2.3** |
| **CO5** | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | **2.4** |
| **CO6** | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | **2.4** |
| | | | | | | | | | | **Mean Overall Score** | **2.4 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 1 | 25PMA1ES01A | **Discipline Specific Elective - 1:** Stochastic Processes | 4 | 3 |

| Course Objectives |
|---|
| To understand the basic concepts and definitions of stochastic processes, including stationary processes, Markov chains, and random walks. |
| To analyze the properties of Markov chains, including transition probabilities and classification of states. |
| To model and analyze various types of Poisson processes and their generalizations, such as birth and immigration processes. |
| To apply renewal process theory to analyze events occurring over time in both discrete and continuous settings. |
| To analyze the steady-state behavior of basic queuing models, including the M/M/1 queue, and understand the fundamentals of non-Markovian queuing systems. |

**UNIT I** **(12 Hours)**

Stochastic processes - Specification of Stochastic processes - Stationary processes - Markov chain-Transition Probabilities-Random Walk

**UNIT II** **(12 Hours)**

Higher transition probabilities - Classification of states -Transient and recurrent states.

**UNIT III** **(12 Hours)**

Poisson process - Generalizations of Poisson process - Pure birth process - Yule-Furry process -Birth-Immigration process.

**UNIT IV** **(12 Hours)**

Renewal process in discrete time - Renewal process in continuous time - Renewal equation -Renewal theorems.

**UNIT V** **(12 Hours)**

Queueing processes - Steady state behaviour of M/M/1 queueing model - Non-Markovian queueing models -Queues with Poisson input (M/G/1)

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, PPT |
| **Assessment Methods** | MCQ, Quiz & Snap Test |

**Books for Study:**

1. Medhi. (1994). *Stochastic Processes*, (2nd Ed.). New Age International Publishers, New Delhi.
   **Unit I** Chapter2: Sections 2.1,2.2, 2.3and Chapter 3: Section 3.1
   **Unit II** Chapter 3: Sections 3.2 and 3.4
   **Unit III** Chapter 4: Sections 4.1,4.3 (omit 4.3.5-4.3.7)
   **Unit IV** Chapter 6: Sections 6.1.1-6.1.3, 6.2(omit example 2(b)), 6.3,6.5(omit6.5.2))
   **Unit V** Chapter 10: Sections 10.1(omit10.1.4),10.2(omit10.2.3.1),10.7 (omitExamples7(a), 7(b) and Sections 10.7.3, 10.7.4).

**Books for Reference:**


1. Bhat, U.N. (1972). *Elements of Applied Stochastic Processes,* (2nd Ed.). John Wiley & Sons, New York.
2. Prabhu, N.V. *Stochastic Processes*. MacMillan, NewYork.
3. Ross, S.M. (1996). *Stochastic Processes,* (2nd Ed.). John Wiley & Sons, NewYork.


**Websites and eLearning Sources:**

1. https://www.stat.auckland.ac.nz/~fewster/325/notes/325book.pdf
2. https://www.probabilitycourse.com/chapter11/11_1_2_basic_concepts_of_the_poisson_process.php
3. https://bookdown.org/manuele_leonelli/SimBook/steady-state-behavior-of-the-mm1-model.html

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Define key terms related to stochastic processes, Markov chains, and queuing theory. | **K1** |
| **CO2** | Explain the differences between various types of stochastic processes, such as stationary, Poisson, and renewal processes. | **K2** |
| **CO3** | Solve problems involving transition probabilities and state classification in Markov chains. | **K3** |
| **CO4** | Compare and contrast different queuing models, identifying the assumptions and limitations of each. | **K4** |
| **CO5** | Assess the suitability of different stochastic process models for real-world applications | **K5** |
| **CO6** | Develop a stochastic model for a given scenario, such as a queuing system or a population growth process. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Title of the Course** | | | | | | | | **Hours** | **Credits** |
| **1** | **25PMA1ES01A** | **Discipline Specific Elective - 1:** Stochastic Processes | | | | | | | | **4** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | **2.4** |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | **2.3** |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | **2.3** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | **2.4** |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO6** | 2 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | **2.3** |
| | | | | | | | | | | **Mean Overall Score** | **2.4 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 1 | 25PMA1ES01B | **Discipline Specific Elective - 1:** Differential Geometry | 4 | 3 |

| Course Objectives |
|---|
| To recall the geometrical ideas over the surfaces, the normals and tangents, curvature and related equations of evolutes and involutes. |
| To understand the interrelation between derivatives and Geometry. |
| To apply the concept learned from Differential geometry in mechanic and also apply the techniques of differential calculus in the field of geometry. |
| To analyse the analytical representation of normal, tangent place and develop surfaces. |
| To evaluate the solutions of the problems in the field of differential geometry. |

**UNIT I** **(12 Hours)**

Analytical representation - Arc length - Tangent - Oscillating plane - Curvature-Torsion - Formulae for Frenet contact.

**UNIT II** **(12 Hours)**

Natural equations - Helices - General solution of natural equations - Evolutes and involutes - Imaginary curves - Ovals.

**UNIT III** **(12 Hours)**

Analytical representation - First fundamental theorem - Normal, tangent plane - Developable surfaces - Second fundamental form - Meusrier's theorem - Euler's theorem.

**UNIT IV** **(12 Hours)**

Dupin's indicatrix - Some surfaces - A geometrical interpretation of a symptotic and curvature lines conjugate directions - Triply orthogonal system of surfaces.

**UNIT V** **(12 Hours)**

Gauss - The equations of Gauss - Weingarten - The theorem of Gauss and the equations of Codazzi curvilinear coordinates in space - Some applications of the Gauss and the Codazzi equations - The fundamental theorem of surface theory.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation |
| **Assessment Methods** | Seminar, Snap Test, MCQ, Library Record, Written Assignment |

**Books for Study:**

1. Dirk J. Struik (1950), *Lectures on Classical Differential Geometry*, Addison Wesley Publishing Company.
   **Unit I** *Chapter 1 (Sec 1.1 - 1.7)*
   **Unit II** *Chapter 1 (Sec 1.8 - 1.13)*
   **Unit III** *Chapter 2 (Sec 2.1 - 2.6)*
   **Unit IV** *Chapter 2 (Sec 2.7 - 2.11)*
   **Unit V** *Chapter 3(Sec 3.1 - 3.6)*

**Books for Reference:**

1. Willmore. T.J (1959), *An introduction to Differential Geometry*, Oxford University Press, New York.
2. Barrett O'Neill (2006), *Elementary Differential Geometry*, Second Edition, Academic Press.

**Websites and eLearning Sources:**

1. https://mathworld.wolfram.com/ArcLength.html
2. https://people.math.ethz.ch/~salamon/PREPRINTS/diffgeo.pdf
3. https://maths-people.anu.edu.au/andrews/DG/DG_chap18.pdf

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Understand and apply analytical representation of curves and surfaces. | **K1** |
| **CO2** | Analyze natural equations and special curves, to solve natural equations and understand their general solutions. | **K2** |
| **CO3** | Examine fundamental theorems of surface theory and understand the properties of normal, tangent planes, and developable surfaces. | **K3** |
| **CO4** | Interpret curvature and geometrical properties of surfaces and investigate Dupin's indicatrix and its applications. | **K4** |
| **CO5** | Explore the applications of Gauss and Codazzi equations in differential geometry. | **K5** |
| **CO6** | Understand the fundamental theorem of surface theory and apply it to curvilinear coordinates. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Title of the Course** | | | | | | | | **Hours** | **Credits** |
| **1** | **25PMA1ES01B** | **Discipline Specific Elective - 1:** Differential Geometry | | | | | | | | **4** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2.3 |
| **CO2** | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2.2 |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2.4 |
| **CO4** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2.4 |
| **CO5** | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2.4 |
| **CO6** | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2.4 |
| | | | | | | | | | **Mean Overall Score** | | **2.35 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 1 | 25PMA1AE01 | **Ability Enhancement Course:** Problem Solving in Advanced Mathematics | 2 | 1 |

| Course Objectives |
|---|
| To understand the concepts in Real Analysis, Algebra and Ordinary differential equations |
| To recall the fundamental ideas in various interpretations of the problems |
| To create many examples to justify the answers |
| To analyze and apply the results and techniques to get solutions |
| To train the students in problem-solving as a preparatory to NET/SET |

**UNIT I** **(6 Hours)**

Sets - open - closed - compact - connected - Sequences and series.

**UNIT II** **(6 Hours)**

Continuity - uniform continuity - differentiability - mean value theorems - Riemann integral - Uniform convergence.

**UNIT III** **(6 Hours)**

Groups - subgroups - normal subgroups - cyclic groups - quotient groups - homomorphisms - permutation groups.

**UNIT IV** **(6 Hours)**

Cayley's theorem - class equations - Sylow theorems - Rings - ideals - quotient rings - prime and maximal ideals.

**UNIT V** **(6 Hours)**

Wronskian - Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, Lectures, Demonstrations, PPT. |
| **Assessment methods** | Seminar, Quiz, Test |

**Books for Study:**

1. Singh, A.P. (2017). *Info Study's Real Analysis*. Info study Publications
   **Unit I:** *Chapter 1*: 1.1, 1.24 - 1.40, *Chapter 2*: 2.1 - 2.2
   **Unit II:** *Chapter 3*: 3.1 - 3.3, 3.5.3,
   *Chapter 2*: 2.3, *Chapter 5*: 5.1
2. Singh, A.P. (2017). *Info Study's Modern Algebra,* Info study Publications
   **Unit III:** *Chapter 1*: 1.1 - 1.2, 1.5 - 1.7, 1.10 *Chapter 2*: 2.1 - 2.4
   **Unit IV:** *Chapter 2*: 2.5 - 2.7, 3.5.3,
   *Chapter 3*: 3.1 - 3.8, 3.10, 3.11, 3.15.6, 3.15.7
3. Singh, A.P. (2017). *Info Study's Differential Equation*, Info study Publications
   **Unit V:** *Chapter 2*: 2.10, *Chapter 3*: 3.1

**Books for Reference:**


1. Rudin, W. (1976). *Principles of Mathematical Analysis*, (3rd Ed.). Mc Graw-Hill International Book Company, New York.
2. Gallian, J.A. (2012). *Contemporary Abstract Algebra*, (7th Ed.). Katherine Tegan Books.
3. Coddington, E.A. (1992). *An Introduction to Ordinary Differential Equations*, Prentice-Hall of India, New Delhi.


***Evaluation Pattern for AEC:***

| Internal (50 Marks) | External (50 Marks) |
|---|---|
| Component 1 (25 Marks) – Assignment | Written Test |
| Component 2 (25 Marks) – Written Test | 10 qns × 5 marks = 50 Marks |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 1 | 25PMA1OE01 | **Open Elective - 1 (WS):** Mathematical Foundations | 4 | 2 |

| Course Objectives |
|---|
| To understand fundamental concepts of mathematical logic and numerical analysis |
| To study the basic properties functions and relations |
| To develop analytical skills through the study of truth table and tautology |
| To understand the relationship between functions and lattices |
| To apply numerical techniques and solve problems in roots of equation and integration |

**UNIT I** **(12 Hours)**

Relations - Equivalence Relation - Functions and Operators - One-to-one, Onto Functions - Special Types of Functions-Invertible Functions- Composition of Function- Mathematical Induction.

**UNIT II** **(12 Hours)**

Logic: Introduction - TF -Statements - Connectives - Conjunction - Disjunction - Negation - Conditional Statements - Biconditional Statements - The Truth Table of a Formula -Tautology.

**UNIT III** **(12 Hours)**

Lattices - Some Properties of Lattices - New Lattices - Lattice Homomorphisms - Product Lattices of Two Lattices - Modular and Distributive Lattices - Boolean Algebra

**UNIT IV** **(12 Hours)**

Iterative Methods: Birge-Vieta - Graeffe's Root Squaring Methods - System of linear algebraic equations: Gauss Elimination, Jacobi iteration method-Gauss-Seidel iteration method

**UNIT V** **(12 Hours)**

Interpolation: Lagrange Interpolation - Newton's Forward Difference Interpolation - Newton's Backward Difference Interpolation-Trapezoidal Rule-Simpson Rule-Romberg integration.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, Problem Solving |
| **Assessment Methods** | Seminar, Snap Test, MCQ |

**Books for Study:**

1. Venkataraman, M.K., Sridharan, N., & Chandrasekaran, N. (2012). *Discrete Mathematics.* The National Publishing Company, Chennai.
   Unit I Chapter II (Sec 2, 5),
   Chapter III (Sec 1, 2, 3, 4, 5),
   Chapter IV (Sec 1,2)
   Unit II Chapter IX (Sec 1, 2, 3, 6, 7)
   Unit III Chapter X (Sec 1,2,3, 4,5) (Only Definitions and examples in Sec 4 &5)
2. Jain, M.K., Iyengar, S.R.K. & Jain R.K. (2007) *Numerical Methods for Scientific and Engineering Computation*, (5th Ed.). New Age International (P) Limited.
   Unit IV (Page no 86-89, 94-99, 114-119, 146-152)
   Unit V (Page No. 235-240,386-393)

**Books for Reference:**

1. Tremblay, J.P. & Manohar, R (1987). *Discrete Mathematical Structures with Applications to Computer Sciences*, McGraw-Hill International.
2. Sastry, S.S. (2009). *Introductory Methods of Numerical Analysis*, (4th Ed.). PHI Learning Private Limited.
3. Kandasamy, P., Thilagavathy, K., & Gunavathi, K. (2008). *Numerical Methods*, S. Chand & Company Ltd.

**Websites and eLearning Sources:**

1. https://brilliant.org/wiki/discrete-mathematics/.
2. https://www.tutorialspoint.com/discrete_mathematics/

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Acquire knowledge of relations, functions, mathematical logic, lattices and numerical methods | **K1** |
| **CO2** | Understand the types of functions, conditional statements and numerical techniques | **K2** |
| **CO3** | Apply mathematical induction, composition of functions and numerical formulae | **K3** |
| **CO4** | Analyze various types of function, statements using truth tables, Boolean algebra numerical methods to find solutions of linear equations and system of equations using different methods | **K4** |
| **CO5** | Justify relations and functions, to construct mathematical arguments using logical connectives and quantifiers, lattices. | **K5** |
| **CO6** | Relate solutions of system of linear equations and numerical integration | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | **Hours** | **Credits** | |
| **1** | **25PMA1OE01** | | | **Open Elective - 1 (WS):** Mathematical Foundations | | | | | **4** | **2** | |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcome (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | **2.5** |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | **2.3** |
| **CO3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | **2.3** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | **2.4** |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO6** | 2 | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | **2.2** |
| **Mean Overall Score** | | | | | | | | | | | **2.35 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 1 | 25PGC1SL01 | Global Citizenship Education | Online | 1 |

| Course Objectives |
|---|
| To develop an understanding of global governance structures, rights and responsibilities. |
| To recognize and respect differences, multiple identities and diversity. |
| To examine beliefs and perceptions about social justice, equality and civic engagement. |
| To develop attitudes of care and empathy for others and the environment. |
| To develop global competence and ethical considerations by enhancing communication and collaboration skills across cultures |

**UNIT I: Introduction to Global Citizenship**

01. Historical and Philosophical Foundations of Global Citizenship
02 Rights and Responsibilities of Global Citizenship
03. Key Organizations and Movements Promoting Global Citizenship

**UNIT II: Globalization and Its Impact on Society**

04. Globalization and Its Key Drivers
05. Positive and Negative Impacts of Globalization
06. Role of Education in Fostering a Global Perspective

**UNIT III: Human Rights, Social Justice, Equality and Diversity**

07. Key Human Rights Treaties, Frameworks and Declarations
08. Advocacy, Activism, and Movements for Social Justice and Equality
09. Global Challenges to Human Rights, Equality and Diversity

**UNIT IV: Sustainable Development and Environmental Responsibility**

10. The Sustainable Development Goals and Their Relevance to Global Citizenship
11. Climate Change, Environmental Degradation and Sustainable Development
12. Strategies for Promoting Environmental Responsibility

**UNIT V: Building Global Competence and Engagement**

13. Effective Communication and Collaboration Across Cultures
14. Volunteering and Community Engagement in Global Initiatives
15. Ethical Considerations in Global Citizenship

| | |
|---|---|
| **Teaching Methodology** | Recorded Lectures/Videos, Reading Materials, PPTs, Case Studies, Collaborative Projects, Quizzes and Polls |
| **Assessment Methods** | Seminars, Assignments, MCQs, Reflection Essays, Group Project Presentations, Problem-Solving Scenarios |

**Books for Study:**


1. Clapham, A. (2007). *Human rights: A very short introduction.* Oxford University Press.
2. Desai, A. (2018). *Global citizenship and cultural diplomacy: India's role in a changing world*. Routledge India.
3. Gould, J. A. (2012). *The ethics of global citizenship*. Routledge.
4. Held, D., et al. (2022). *Globalization and its impact on the developing world*. Cambridge University Press.
5. Sen, A. (2009). *The idea of justice*. Penguin Books India.


**Books for Reference:**


1. Ghosh, A. (2007). *The global impact of Indian civilization*. HarperCollins India.
2. Krecker, E. (2008). *The global citizen: A guide to creating an international life and career*. Career Press.
3. Kumar, R. (2017). *Sustainable development and environmental justice in India*. Oxford

University Press.
4. Nair, K. G. (2014). *Human rights: A socio-political perspective*. Orient Blackswan.
5. Patel, V. (2015). *Social justice and equality in India: Theories and practices*. Oxford University Press.
6. Pillai, V. (2016). *Globalization and its impact on Indian society*. SAGE Publications India.

**Websites and eLearning Sources:**

1. https://www.unesco.org/en/global-citizenship-peace-education/need-know
2. TEDxCincinnati: Global Citizenship in the Classroom: Jenny Buccos at TEDxCincinnati https://www.youtube.com/watch?v=6jjLHmyBs7o
3. Social justice -- is it still relevant in the 21st century? | Charles L. Robbins | TEDxSBU https://www.youtube.com/watch?v=Wtroop739uU
4. Are We the Last Generation — or the First Sustainable One? | Hannah Ritchie | TED https://www.youtube.com/watch?v=Kl3VVrggKz4
5. Diversity, Equity & Inclusion. Learning how to get it right | Asif Sadiq | TEDxCroydon https://www.youtube.com/watch?v=HR4wz1b54hw

| **Course Outcomes** | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Recall the historical, philosophical and practical foundations of global citizenship. | **K1** |
| **CO2** | Explain the key drivers of globalization and the role of education in fostering a global perspective. | **K2** |
| **CO3** | Apply human rights frameworks, social justice principles, and advocacy strategies to real-world challenges. | **K3** |
| **CO4** | Analyze the relevance of the Sustainable Development Goals in addressing climate change and environmental degradation. | **K4** |
| **CO5** | Develop strategies for fostering global competence by enhancing communication and collaboration skills across cultures. | **K5** |
| **CO6** | Critically evaluate the effectiveness of current global strategies and policies in addressing social justice and environmental sustainability. | **K6** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 2 | 25PMA2CC05 | **Core Course - 5:** Advanced Algebra | 6 | 4 |

| Course Objectives |
|---|
| To gain deep understanding of important concepts of extension fields, roots of polynomials, field theory and develop proficiency in their applications. |
| To investigate the structure and behaviour of algebraic systems and classify them based on certain properties, and apply the concepts to solve various mathematical problems in diverse areas of studies. |
| To understand the concepts of galois theory in discussing the existence of roots of the polynomials and analyse their behaviours in various mathematical contexts. |
| To simplify the nature of the finite division ring and classify the division ring algebraic over the field of real and complex numbers. |
| To provide insights into finite fields and finite division rings. |

**UNIT I** **(18 Hours)**

Polynomial Rings - Extension fields

**UNIT II** **(18 Hours)**

Roots of Polynomials - More about roots

**UNIT III** **(18 Hours)**

Elements of Galois theory – Normal Extension

**UNIT IV** **(18 Hours)**

Finite fields - Wedderburn's theorem on finite division rings.

**UNIT V** **(18 Hours)**

A theorem of Frobenius - Integral Quaternions and the Four - Square theorem

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation |
| **Assessment Methods** | Seminar, Snap Test, MCQ |

**Books for Study:**

1. Herstein, I. N. (1975), *Topics in Algebra* (2nd Ed.) Wiley Eastern Limited.
   **Unit I** Chapter 3: Section 3.9, Chapter 5: Section 5.1
   **Unit II** Chapter 5: Sections 5.3 and 5.5
   **Unit III** Chapter 5: Section 5.6
   **Unit IV** Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)
   **Unit V** Chapter 7: Sections 7.3 and 7.4

**Books for Reference:**


1. Artin, M. (1991). *Algebra.* Prentice Hall of India.
2. Bhattacharya, P. B., Jain, S. K., &Nagpaul, S.R. (1997). *Basic Abstract Algebra* (2nd Ed.). Cambridge University Press.
3. Luther, I. S. & Passi, I. B. S. (1996). *Algebra, Vol. I -Groups; Vol. II Rings*, Narosa Publishing House.
4. Malik, D. S., Mordeson, J. N., & Sen, M. K. (1997). *Fundamental of Abstract Algebra*, McGraw-Hill.
5. Jacobson, N. (1980). *Basic Algebra, Vol. I & II W.H. Freeman.* Hindustan Publishing Company.


**Websites and eLearning Sources:**

1. http://mathforum.org
2. http://ocw.mit.edu/ocwweb/Mathematics,
3. http://www.opensource.org
4. www.algebra.com

5. https://nptel.ac.in/courses/111101001

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Recall basic concepts on vector spaces, define finite extension, Galois groups and finite fields | **K1** |
| **CO2** | Classify the roots of a polynomial, summarize remainder theorem, understand the characteristics of a field, summarize Wedderburn's theorem and Frobenius theorem. | **K2** |
| **CO3** | Relate correspondence between the subfields of the splitting field and the subgroups of its Galois group. | **K3** |
| **CO4** | Illustrate extension fields, finite fields and fixed fields with examples. | **K4** |
| **CO5** | Demonstrate knowledge and understanding of fundamental concepts including extension fields, algebraic extensions and finite fields. | **K5** |
| **CO6** | Develop new results based on Wedderburn's theorem, Frobenius theorem and the Four-square theorem. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | **Title of the Course** | | | | | | | **Hours** | **Credits** |
| **2** | **25PMA2CC05** | | **Core Course - 5:** Advanced Algebra | | | | | | | **6** | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | **2.5** |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | **2.3** |
| **CO3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | **2.3** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | **2.6** |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO6** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| | | | | | | | | | | **Mean Overall Score** | **2.42 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 2 | 25PMA2CC06 | **Core Course - 6:** Real Analysis - 2 | 5 | 4 |

| Course Objectives |
|---|
| To give the thorough knowledge of the various aspects of Integration, Differentiation and convergence |
| To train the students for advanced learning in pure mathematics |
| To give the students the knowledge of analyzing and approaching life |
| To train the students to apply pure mathematics to applied problems |
| To train the students in problem solving as a preparatory to NET/SET |

**UNIT I** **(15 Hours)**

Functions of bounded variations - Total Variation - Continuous functions of bounded variation.

**UNIT II** **(15 Hours)**

The Riemann – Stieltjes integral - Linear properties - Integration by parts - Step function as integrators - Monotonically increasing integrators - Comparison theorems.

**UNIT III** **(15 Hours)**

Infinite series and infinite product - Convergent and divergent sequence of complex numbers - Limit superior and limit inferior - Monotonic sequence of real numbers - Absolute and conditional convergence - The geometric series - Dirichlet's test and Abel's test - Rearrangement of series - Riemann theorem on conditionally convergent series.

**UNIT IV** **(15 Hours)**

Double sequences - Multiplication of series - Cesaro summability - Infinite product -multivariable differential calculus -directional derivative and continuity -the total derivative.

**UNIT V** **(15 Hours)**

Sequence of functions -pointwise convergence of sequence -uniform convergence - The Cauchy condition for uniform convergence - Uniform convergence and Riemann - Stieltjes integration.

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk method, Problem solving, Snap Test |
| **Assessment Methods** | Snap test, Seminar, MCQ |

**Books for Study:**

1. Tom M Apostol, *Mathematical Analysis*, Addison-Wesley Publishing Company, London, 1974.

**Unit - I** *Chapter 6(Sec:6.1-6.8)*
**Unit - II** *Chapter 7(Sec:7.1-7.8, 7.11-7.14)*
**Unit - III** *Chapter 8(Sec:8.1 -8.11,8.15,8.17,8.18)*
**Unit - IV** *8(Sec:8.20 -8.26,12.1- 12.4)*
**Unit - V** *Chapter 9(Sec:9.1-9.8)*

**Book for Reference:**

1. Richard R Goldberg, "***Methods of Real Analysis"***, Oxford & IBH Publishing Company, New Delhi, 1970
2. Walter Rudin, ***Principles of Mathematical Analysis***, Third Edition, McGraw-Hill International Book Company, New York, 1976

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=bWTmUWWZnhQ
2. https://www.youtube.com/watch?v=ckZpIsjzm0I
3. https://www.youtube.com/watch?v=VLv1adcoiWo&list=PLbMVogVj5nJSxFihV-ec4A3z_FOGPRCo-&index=8

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Acquire knowledge of Riemann-Stieltjes Integrals, continuity and uniform convergence of series of functions. | **K1** |
| **CO2** | Understand the properties of integration and some special functions | **K2** |
| **CO3** | Apply integration, various types of convergence in problems. | **K3** |
| **CO4** | Analyze the abstract ideas and various methods in mathematical analysis and apply them to practical problems. | **K4** |
| **CO5** | Evaluate problems on the concepts learned. | **K5** |
| **CO6** | Construct mathematical proofs for basic results. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **2** | **25PMA2CC06** | | | **Core Course - 6:** Real Analysis - 2 | | | | | | **5** | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1.8 |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 2 |
| **CO3** | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2.2 |
| **CO4** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 1.9 |
| **CO6** | 3 | 2 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | 2 | 2.2 |
| | | | | | | | | | | **Mean Overall Score** | **2.02 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 2 | 25PMA2CC07 | **Core Course - 7:** Complex Analysis | 6 | 4 |

| Course Objectives |
|---|
| To develop Knowledge and understand the fundamental concepts of Analytic Functions |
| To enhance problem-solving skills with line integrals |
| To enable the use of singularities |
| To enrich a proper understanding of definite integrals |
| To develop Knowledge about power series expansion |

**UNIT I** **(18 Hours)**

Concept of Analytic Function, Limits and Continuity - Analytic Functions - Polynomials-Rational Functions-Power series-Abel's Limit Theorem.

**UNIT II** **(18 Hours)**

Complex Integration - Fundamental Theorems - Line Integrals - Rectifiable arcs - Line integrals as Functions of Arcs - Cauchy's Theorem for a Rectangle - Cauchy's Theorem in a Disk.

**UNIT III** **(18 Hours)**

Cauchy's Integral Formula - The index of appoint with respect to a closed curve - The integral formula-Higher Derivatives - Removable Singularities - Taylor's Theorem.

**UNIT IV** **(18 Hours)**

The Maximum principle - The Calculus of Residues - The Residue theorem - The Argument principle-Evaluation of Definite Integrals.

**UNIT V** **(18 Hours)**

Harmonic functions, Power Series expansion - Poisson's Formula - Schwarz's Theorem -Weierstrass's Theorem-The Taylor series -The Laurent series

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, PPT |
| **Assessment Methods** | MCQ, Snap Test, Seminar |

**Book for Study:**

1. Ahlfors, L.V. (2013). *Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable,* (3rd Ed.). Mac Millan Publishers.
   **UNIT-I** *Chapter2 (sec:1.1-1.4,2.4&2.5Pages21-33,38-42)*
   **UNIT-II** *Chapter4 (sec1.1-1.5Pages101-114)*
   **UNIT-III** *Chapter4 (sec2.1-2.3, 3.1Pages114-126)*
   **UNIT-IV** *Chapter4 (sec3.4,5.1-5.3Pages133-137,148-161)*
   **UNIT-V** *Chapter4 (sec6.1 - 6.4) Chapter 5 (sec1.1-1.3Pages 162-172,175-186)*

**Books for Reference:**

1. Conway, J.B. (1978). *Function of one Complex Variable.* (2nd Ed.). Springer Graduate Texts in Mathematics.
2. Ponnusamy, S. (2005). *Foundations of Complex Analysis*, (2nd Ed.). Narosa Publishing House.

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=u2FciQPQuWg&list=PLbMVogVj5nJTSPDysVOzVPd0N1AHYqUhH&index=1
2. https://www.youtube.com/watch?v=koqIC3FLmx0&list=PLbMVogVj5nJTSPDysVOzVPd0N1AHYqUhH&index=2
3. https://www.youtube.com/watch?v=oTbrjUfNP5I&list=PLbMVogVj5nJTSPDysVOzVPd0N1AHYqUhH&index=8

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K - Level)** |
| **CO1** | Acquire knowledge on fundamental concepts of Analyticity, Complex integration and Harmonic Functions. | **K1** |
| **CO2** | Understand the behavior of Analytic Functions, Taylor's and Laurent's Series expansions. | **K2** |
| **CO3** | Apply C-R equations, Residue Theorem in solving problems involving complex function theory. | **K3** |
| **CO4** | Demonstrate a good understanding of Mathematical reasoning through Cauchy's Theorem. | **K4** |
| **CO5** | Evaluate integrals, region of convergence and contour integrals. | **K5** |
| **CO6** | Analyze sequence and series of analytic functions, types of convergence, apply the concept and consequences of harmonic function, represent functions as Taylor and Laurent series | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | **Hours** | | **Credits** |
| **2** | **25PMA2CC07** | | | **Core Course - 7:** Complex Analysis | | | | | **6** | | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 2 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | **2.3** |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | **2.2** |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | **2.3** |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | **2.1** |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | **2.2** |
| **CO6** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | **2.2** |
| | | | | | | | | | | **Mean Overall Score** | **2.2 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 2 | 25PMA2CC08 | **Core Course - 8:** Mathematical Modelling (Internship Embedded Course) | 5 | 4 |

| Course Objectives |
|---|
| To introduce the concepts of mathematical modelling. |
| To develop an understanding of approximation and assumptions in mathematical modelling. |
| To improve analytical thinking and creativity in solving complex problems. |
| To emphasize model validation through comparison with signed graphs, weighted graphs. |
| To give a wide range view of applications of mathematics in science and technology. |

**UNIT I: Mathematical Modelling Through Ordinary Differential Equations of First Order : (15 Hours)**

Linear Growth and Decay Models - Non-Linear Growth and Decay Models - Compartment Models - Dynamics problems.

**UNIT II: Mathematical Modelling Through Systems of Ordinary Differential Equations of First Order: (15 Hours)**

Population Dynamics - Epidemics - Compartment Models - Economics - Medicine, Arms Race, Battles and International Trade.

**UNIT III: Mathematical Modelling Through Ordinary Differential Equations of Second Order: (15 Hours)**

Planetary Motions - Circular Motion and Motion of Satellites - Mathematical Modelling through Linear Differential Equations of Second Order - Miscellaneous Mathematical Models.

**UNIT IV: Mathematical Modelling Through Difference Equations: (15 Hours)**

Simple Models - Basic Theory of Linear Difference Equations with Constant Coefficients - Economics and Finance - Population Dynamics and Genetics - Probability Theory.

**UNIT V: Mathematical Modelling Through Graphs (15 Hours)**

Situations which can be Modelled through Graphs - Mathematical Modelling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs and Unoriented Graphs.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models |
| **Assessment Methods** | Seminar, Snap Test, MCQ, Case Study |

**Books for Study:**

1. Kapur, J.N Mathematical Modelling, (2023), 3rd Edition, New Age International Private Limited, New Delhi.
   **Unit-I** Chapter 2 (Sec: 2.1-2.5)
   **Unit-II** Chapter 3 (Sec: 3.1-3.5)
   **Unit-III** Chapter 4 (Sec: 4.1-4.4)
   **Unit-IV** Chapter 5 (Sec: 5.1-5.5)
   **Unit-V** Chapter 7 (Sec: 7.1-7.5)

**Books for Reference:**

1. Kapur, J.N (2001) Mathematical Models in Biology and Medicine, Affiliated East - West Press Pvt Limited, New Delhi.

**Websites and eLearning Sources:**

1. https://nptel.ac.in/courses/111/107/111107113/
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ma18/
3. http://www.digimat.in/nptel/courses/video/111107113/L12.html

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Understand the concept of a mathematical model and explain the series of steps involved in mathematical modelling. | **K1** |
| **CO2** | Discuss features of a good model and the benefits of using a mathematical model. | **K2** |
| **CO3** | Convert the physical problems as differential equations through mathematical modelling. | **K3** |
| **CO4** | Use the ideas of directed graphs, weighted digraphs and unoriented graphs for modelling real life problems. | **K4** |
| **CO5** | Model the problems in economics and finance, population dynamics and genetics. | **K5** |
| **CO6** | Solve problems in engineering, physical, biological, social and behavioural sciences. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | **Title of the Course** | | | | | | | **Hours** | **Credits** |
| **2** | **25PMA2CC08** | | **Core Course - 8:** Mathematical Modelling (Internship Embedded Course) | | | | | | | **5** | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | **2.4** |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | **2.7** |
| **CO6** | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | **2.6** |
| **Mean Overall Score** | | | | | | | | | | | **2.53 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 2 | 25PMA2OE02 | **Open Elective - 2 (BS):** Operations Research | 4 | 2 |

| Course Objectives |
|---|
| To equip students with the Operation Research techniques needed for understanding theoretical treatment in business field. |
| To acquire knowledge of transportation problem and assignment problem on different categories. |
| To compare the basic feasible solution using various methods and predict suitable decision under certainty and uncertainty. |
| To discuss the replacement problems of equipment/asset that deteriorates gradually and suddenly. |
| To estimate best network scheduling and evaluate expected time for the completion of project. |

**UNIT I** **(12 Hours)**

Transportation Problem: Introduction - Finding an initial basic feasible solution: North-west corner method - Least cost or matrix minima method - Vogel's approximation method - Test for optimality - Transportation algorithm (MODI method) - Some exceptional Cases: Unbalanced transportation problem.

**UNIT II** **(12 Hours)**

Assignment Problem: Introduction -Solution methods of assignment problem: HungarianAssignment Method - Linear programming problem - graphical solution: Graphical solution method

**UNIT III** **(12 Hours)**

Decision Analysis: Introduction - Decision-making problem - Decision-making environment - Decisions under uncertainty: the max-min or min-max criterion - the savage regret criterion
the Hurwitz criterion.

**UNIT IV** **(12 Hours)**

Replacement Problem: Introduction - Replacement of equipment/asset that deterioratesgradually - Replacement of equipment that fails suddenly.

**UNIT V** **(12 Hours)**

Network Scheduling by PERT/CPM: Introduction - Network: Basic components - Logical sequencing -Rules of network construction: numbering the events - Concurrent activities - Critical path Analysis - Probability considerations in PERT.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models, Graphical representation using problems |
| **Assessment Methods** | Seminar, Online Test, MCQ |

**Books for Study:**

1. Kanti Swarup, P.K. Gupta and Man Mohan, *Operations Research*, Thirteenth Thoroughly Edition, Sultan Chand and Sons, New Delhi, 2007.
   - **Unit-I** *Chapter 10 (Sec 10.1, 10.9, 10.10, 10.13 and 10.15)*
   - **Unit-II** *Chapter 11(Sec 11.1, 11.3), Chapter 3 (Sec 3.1 to 3.3)*
   - **Unit-III** *Chapter 16 (Sec 16.1, 16.2, 16.4 and 16.5)*
   - **Unit-IV** *Chapter 18 (Sec 18.1 - 18.3) (problems only and no proof of theorems)*
   - **Unit-V** *Chapter 25 (Sec 25.1 - 25.7)*

**Books for Reference:**


1. J. K. Sharma, *Operations Research Theory & Applications*, Macmillan India Ltd., Fourth Edition, 2009.
2. Sundaresan. V, Ganapathy Subramanian. K.S. and Ganesan. K, *Resource Management Techniques*, A.R. Publications, Chennai 2014.
3. Taha H.A., *Operations Research: An introduction*, Eighth Edition, Pearson Prentice Hall, 2007.

**Websites and eLearning Sources:**

1. https://www.mmmut.ac.in/News_content/11235dep-notice_11072020.pdf
2. https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/1585041316993_Module-4.pdf
3. https://icmai.in/upload/AdvStudies/UPSC/1308_22_4.pdf

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Acquire knowledge of transportation problem, assignment problem, decision-making problem, replacement problem and network scheduling analysis. | **K1** |
| **CO2** | Compare the basic feasible solution using various methods and predict suitable decision under uncertainty and best critical path. | **K2** |
| **CO3** | Differentiate balanced and unbalanced problem, feasible and optimum solution and PERT and CPM. | **K3** |
| **CO4** | Compute optimum solution of transportation problem, assignment problem, decision-making problem, replacement problem and network scheduling. | **K4** |
| **CO5** | Estimate best network scheduling and evaluate expected time for the completion of project. | **K5** |
| **CO6** | Create network diagrams using PERT/CPM techniques to analyze project schedules, identify critical paths, and assess the probability of project completion within specified timeframes. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **2** | **25PMA2OE02** | | | **Open Elective - 2 (BS):** Operations Research | | | | | | **4** | **2** |
| **Course Outcomes** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | **2.1** |
| **CO2** | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | **2.1** |
| **CO3** | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | **2.2** |
| **CO4** | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 2 | **2.3** |
| **CO5** | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | **2.3** |
| **CO6** | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | **2.2** |
| | | | | | | | | | | **Mean Overall Score** | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 2 | 25PSS2SE01 | **Skill Enhancement Course:** Soft Skills | 4 | 2 |

| Course Objectives |
|---|
| To provide a focused training on soft skills for students in colleges for better job prospects |
| To communicate effectively and professionally |
| To help the students take active part in group dynamics |
| To familiarize students with numeracy skills for quick problem solving |
| To make the students appraise themselves and assess others |

**Unit I: Effective Communication & Professional Communication (12 Hours)**

Definition of communication - Barriers of Communication - Non-verbal Communication. Effective Communication - Conversation Techniques - Good manners and Etiquettes - Speech Preparations & Presentations - Professional Communication.

**Unit II: Resume Writing & Interview Skills (12 Hours)**

*Resume Writing:* What is a résumé? Types of résumés – Chronological - Functional and Mixed Resume - Purpose and Structure of a Resume - Model Resume.

*Interview Skills:* Types of Interviews - Preparation for an interview – Attire - Body Language - Common interview questions - Mock interviews & Practicum.

**Unit III: Group Discussion & Personal effectiveness (12 Hours)**

Basics of Group Discussion- Parameters of GD- Topics for Practice - Mock GD & Practicum & Team Building. *Personal Effectiveness*: Self Discovery - Goal Setting with questionnaires & Exercises.

**Unit IV: Numerical Ability (12 Hours)**

Introducing concepts - Average – Percentage - Profit and Loss - Simple Interest - Compound Interest - Time and Work - Pipes and Cisterns.

**Unit V: Test of Reasoning (12 Hours)**

*Introducing Verbal Reasoning:* Series Completion – Analogy - Data Sufficiency - Assertion and Reasoning and Logical Deduction. *Non-Verbal Reasoning*: Series - and Classification.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models, Video presentation |

**Books for Study:**


1. Melchias G., Balaiah, J. & Joy, J. L. (Eds). (2018). Winner in the Making: A Primer on soft Skills. Trichy, India: St. Joseph's College.


**Books for Reference:**


1. Aggarwal, R. S. (2010). A Modern Approach to Verbal and Non- Verbal Reasoning. S. Chand.
2. Covey, S. (2004). 7 Habits of Highly effective people. Free Press.
3. Gerard, E. (1994). The Skilled Helper (5th Ed.). Brooks/Cole.
4. Khera, S. (2003). You Can Win. Macmillan Books.
5. Murphy, R. (1998). Essential English Grammar, (2nd Ed.). Cambridge University Press.
6. Sankaran, K., & Kumar, M. (2010). Group Discussion and Public Speaking (5th Ed.). M.I. Publications.
7. Trishna, K. S. (2012). How to do well in GDS & Interviews? (3rd Ed.). Pearson Education.
8. Yate, M. (2005). Hiring the Best: A Manager 's Guide to Effective Interviewing and Recruiting


**Websites and eLearning Sources:**

3. https://www.indeed.com/career-advice/resumes-cover-letters/communication-skills
4. https://www.seek.com.au/career-advice/article/50-communication-skills-for-the-workplace-your-resume
5. https://southeast.iu.edu/career/files/power-phrases.pdf
6. https://dese.ade.arkansas.gov/Files/20201209124449_Professional-Communication.docx

7. https://www.dol.gov/sites/dolgov/files/ETA/publications/00-wes.pdf
8. https://www.tmu.ac.in/other_websites/cdoe.tmu.ac.in.old/study-material/28-08-2024/COMMON/SEMESTER_2/MAIN_SOFT_SKILLS.pdf
9. https://byjus.com/maths/profit-and-loss-questions/
10. https://www.indiabix.com/

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Recall various soft skill sets | **K1** |
| **CO2** | Understand personal effectiveness in any managerial positions | **K2** |
| **CO3** | Apply verbal and non-verbal reasoning skills to solve problems | **K3** |
| **CO4** | Differentiate problems at work and home; and design solutions to maintain work-life balance | **K4** |
| **CO5** | Assess growth and sustainability and infuse creativity in employment that increases professional productivity | **K5** |
| **CO6** | Construct plans and strategies to work for better human society | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | **Title of the Course** | | | | | | | **Hours** | **Credits** |
| **2** | **25PSS2SE01** | | **Skill Enhancement Course:** Soft Skills | | | | | | | **4** | **2** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2.7 |
| **CO2** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2.9 |
| **CO3** | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2.8 |
| **CO4** | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2.8 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2.8 |
| **CO6** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2.8 |
| **Mean Overall Score** | | | | | | | | | | | **2.8 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 3 | 25PMA3CC09 | **Core Course - 9:** Topology | 6 | 5 |

| Course Objectives |
|---|
| To understand the general topological concepts and point set topology |
| To understand continuity, compactness and connectedness in topological spaces |
| To acquire sufficient knowledge and skill in the subject that will make them competent in various areas of Mathematics. |
| To gain knowledge of advanced concepts in topology and sufficient conditions for metrizability of a topological space |
| To stimulate the analytical thinking through the understanding of abstract concepts of topology. |

**UNIT I** **(18 Hours)**

Topological spaces - Basis for a topology - The order topology - The product topology on $X \times Y$ - The subspace topology - Closed sets and limit points - Continuous functions.

**UNIT II** **(18 Hours)**

The Product topology - The Metric Topology - Connected Spaces - Connected Subspaces of the Real line - Components and local connectedness.

**UNIT III** **(18 Hours)**

Compact spaces - Compact subspaces of the real line - Limit point compactness.

**UNIT IV** **(18 Hours)**

The Countability axioms - The Separation axioms - Normal spaces.

**UNIT V** **(18 Hours)**

The Urysohn lemma - The Urysohn Metrization Theorem - Tietz Extension theorem

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, Discussion, Problem solving, Open source reference. |
| **Assessment Methods** | Seminar, snap test, open book test, group discussion, MCQ, Library record, quiz. |

**Books for Study:**

1. James R. Munkres, *Topology*, Second Edition, PHI Learning Pvt Ltd., New Delhi, 2009.
   **Unit-I** *Chapter 2 (Sec 12-18)*
   **Unit-II** *Chapter 2 (Sec 19-21) and Chapter 3 (Sec 23-25)*
   **Unit-III** *Chapter 3 (Sec 26-28)*
   **Unit-IV** *Chapter 4 (Sec 30-32)*
   **Unit-V** *Chapter 4 (Sec 33-35)*

**Books for Reference:**


1. James Dugundji, *Topology*, Allyn & Bacon, 1966.
2. Sze-TsenHu, *Elements of General Topology*, Holden - Day Series in Mathematics, 1964.
3. Joshi, K. D. (1983). Introduction to general topology. New Age International.


**Websites and eLearning Sources:**

1. http://www.mdudde.net/books/ma/ma-maths/1st/topology-final.pdf

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Acquire knowledge about various types of topological spaces and their properties. | **K1** |
| **CO2** | Understand the definitions with examples of fundamental concepts and results in general topology. | **K2** |
| **CO3** | Apply the properties of open sets, closed sets, interior points, accumulation points and derived sets in deriving the proofs of various theorems. | **K3** |
| **CO4** | Explain the basic concepts of topological spaces such as continuity, compactness, connectedness, regular spaces, normal spaces and the extension theorems. | **K4** |
| **CO5** | Appraise the topological properties in the given space. | **K5** |
| **CO6** | Compile various concepts of topology to establish theorems | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **3** | **25PMA3CC09** | | | **Core Course - 9:** Topology | | | | | | **6** | **5** |
| **Course Outcomes** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2.5 |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | 2.3 |
| **CO3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2.3 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.6 |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2.4 |
| **CO6** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2.4 |
| | | | | | | | | | | **Mean Overall Score** | 2.42 (High) |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 3 | 25PMA3CC10 | **Core Course - 10:** Measure and Integration | 6 | 5 |

| Course Objectives |
|---|
| To describe the approach of the construction of Lebesgue measure and Lebesgue integral of a function and measure spaces. |
| To Know principal theorems and their proofs and be able to use them in the investigation of examples. |
| To prove simple propositions concerning measure spaces, Lebesgue measure and integration. |
| To gain understanding of abstract measure theory and definition and main properties of the integral. |
| To construct the signed measure and product measure and understand the concepts using relevant theorems |

**UNIT I** **(18 Hours)**

**Lebesgue Measure and Measurable sets**: Introduction - Outer measure - Measurable sets and Lebesgue Measure - A non-measurable set

**UNIT II** **(18 Hours)**

**Measurable Functions and Lebesgue Integral**: Measurable Functions - Little Wood's three principles. (Proof of Egoroff's theorem and Lusin's theorem to be omitted) – Riemann integral - Lebesgue Integral of bounded measurable function

**UNIT III** **(18 Hours)**

**Lebesgue Integral (Further Topics) and Differentiation:** - Lebesgue Integral of a nonnegative function - General Lebesgue integral - Convergence in measure - Differentiation of monotone functions.

**UNIT IV** **(18 Hours)**

**Differentiation and Integration:** Functions of bounded variation - Differentiation of an integral - absolute continuity - Convex functions.

**UNIT V** **(18 Hours)**

**Signed measures and Product measures:** Measure spaces - Signed measure - Radon-Nikodhym theorem - Product measures - Fubini's theorem –Tonelli's theorem

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, PPT |
| **Assessment Methods** | Seminar, Snap Test, MCQ, Writing assignments |

**Books for Study:**

1. Royden. H. L, "*Real Analysis"*, Third Edition, Prentice Hall of India, New Delhi,2007.
   **Unit-I** *Chapter 3 (Sec. 1 – 4)*
   **Unit-II** *Chapter 3 (Sec. 5&6) and Chapter 4 (Sec. 1&2)*
   **Unit-III** *Chapter 4 (Sec. 3&5) and Chapter 5 (Sec. 1)*
   **Unit-IV** *Chapter 5 (Sec. 2&5)*
   **Unit-V** *Chapter 11 (Sec.1,5,6) and Chapter 12 (Sec. 4,5)*

**Books for Reference:**

1. De Barra. G, *Measure Theory and Integration*, New Age International Publishers, NewDelhi, 2008.
2. Walter Rudin, *Real and Complex Analysis*, Mc-Graw Hill Book Company, New York,1970.

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=AomWn-hIhm8&list=PLyqSpQzTE6M8hq1wo3TIXYsc0Bf7irjnO&index=17
2. https://www.youtube.com/watch?v=oj-arnLwPMo&list=PLyqSpQzTE6M8hq1wo3TIXYsc0Bf7irjnO&index=22
3. https://www.youtube.com/watch?v=fV9MRXeEbx8&list=PLyqSpQzTE6M8hq1wo3TIXYsc0Bf7irjnO&index=23

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K - Levels)** |
| **CO1** | Have knowledge of integration using measures. | **K1** |
| **CO2** | Understand the analysis in abstract situations. | **K2** |
| **CO3** | Identify integral of derivative with differentiation of an integral. | **K3** |
| **CO4** | Analyze the basic results associated to Measurable functions,Integration Signed measure, decomposition theorems. | **K4** |
| **CO5** | Construct Outer measure in $\sigma - algebra$ and formulate Measurable functions. | **K5** |
| **CO6** | Relate Extension theorems and analyze product measures and Fubini's theorem. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **3** | **25PMA3CC10** | | | **Core Course - 10:** Measure and Integration | | | | | | **6** | **5** |
| **Course Outcomes** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 3 | 3 | 3 | 2.2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2.3 |
| **CO3** | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.3 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 2.3 |
| **CO5** | 1 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 1.9 |
| **CO6** | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2.3 |
| **Mean Overall Score** | | | | | | | | | | | 2.21 (High) |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 3 | 25PMA3CC11 | **Core Course - 11:** Classical Dynamics | 5 | 3 |

| Course Objectives |
|---|
| To gain a strong foundation in mechanical systems, generalized coordinates, constraints, virtual work, and the principles of energy and momentum. |
| To derive and apply Lagrange's equations to various physical systems and analyze integrals of motion. |
| To understand Rayleigh's dissipation function, impulsive motion, and velocity-dependent potentials. |
| To learn Hamilton's principle, Hamilton's equations, and various variational principles to describe mechanical systems. |
| To develop expertise in Hamilton's principal function, the Hamilton-Jacobi equation, and the concept of separability in dynamic systems. |

**UNIT I** **(15 Hours)**

Introductory concepts: The mechanical system - Generalized Coordinates - constraints - virtual work - Energy and momentum.

**UNIT II** **(15 Hours)**

Lagrange's equation: Derivation and examples - Integrals of the Motion.

**UNIT III** **(15 Hours)**

Rayleigh's Dissipation function - Impulsive motion - Velocity dependent potentials.

**UNIT IV** **(15 Hours)**

Hamilton's equations: Hamilton's principle - Hamilton's equations - Other variational principles.

**UNIT V** **(15 Hours)**

Hamilton - Jacobi Theory: Hamilton's Principal Function - The Hamilton - Jacobi equation - Separability.

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, PPT, Problem solving |
| **Assessment Methods** | Seminar, Snap Test, MCQ, Writing assignments |

**Books for Study:**

1. Greenwood, D. T. (1997). *Classical dynamics*. Dover Publications.
   **Unit-I:** *Chapter 1: Sections 1.1 to 1.5*
   **Unit-II:** *Chapter 2: Sections 2.1 to 2.3*
   **Unit-III:** *Chapter 3: Sections 3.1 - 3.2 and 3.4*
   **Unit-IV:** *Chapter 4: Sections 4.1 to 4.3*
   **Unit-V:** *Chapter 5: Sections 5.1 to 5.3*

**Books for Reference:**

1. Goldstein, H. (1998). *Classical mechanics* (2nd ed.). Narosa Publishing House.
2. Synge, J. L., & Griffith, B. A. (2017). *Principles of mechanics* (3rd ed.). McGraw-Hill.
3. Rana, N. C., & Joag, P. S. C. (1991). *Classical mechanics*. Tata McGraw-Hill.

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=2clf7jPxuJY&list=PLyqSpQzTE6M_d9f-9fKxUQYR1qI5YEnSz
2. https://www.youtube.com/watch?v=sERzHGJn7lM&list=PLyqSpQzTE6M_d9f-9fKxUQYR1qI5YEnSz&index=5

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, the students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Recall fundamental principles of mechanical systems, generalized coordinates, constraints, virtual work, energy, and momentum, as well as key formulations in Lagrangian and Hamiltonian mechanics. | **K1** |
| **CO2** | Explain the derivation of Lagrange's and Hamilton's equations, integrals of motion, Rayleigh's dissipation function, impulsive motion, velocity-dependent potentials, and Hamilton-Jacobi theory. | **K2** |
| **CO3** | Apply Lagrange's equations, Hamilton's principles, and the Hamilton-Jacobi equation to solve complex mechanical problems involving constrained and unconstrained motion. | **K3** |
| **CO4** | Analyze various mechanical systems using Lagrangian and Hamiltonian formulations, compare different variational principles, and evaluate the role of energy conservation in dynamic systems. | **K4** |
| **CO5** | Critically evaluate different approaches in classical mechanics, such as Newtonian, Lagrangian, and Hamiltonian formulations, to determine their effectiveness in solving specific physical problems. | **K5** |
| **CO6** | Integrate knowledge of classical mechanics to design and develop innovative solutions for real-world mechanical problems, including systems with dissipative forces, velocity-dependent potentials, and impulsive forces. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **3** | **25PMA3CC11** | | | **Core Course - 11:** Classical Dynamics | | | | | | **5** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | **2.3** |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | **2.4** |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | **2.5** |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | **2.6** |
| **CO6** | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | **2.3** |
| | | | | | | | | | | **Mean Overall Score** | **2.4 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 3 | 25PMA3CC12 | **Core Course - 12:** Algebraic Number Theory | 5 | 3 |

| Course Objectives |
|---|
| To understand the basic concepts such as divisibility, primes, congruences and solutions in congruences |
| To know some techniques of abstract algebra to study integers |
| To highlight the knowledge on Quadratic residues |
| To highlight some of the Applications of the Theory of Numbers. |
| To get the more knowledge on Diophantine Equations |

**UNIT I** **(15 Hours)**

Introduction - Divisibility - Primes - The Binomial Theorem.

**UNIT II** **(15 Hours)**

Congruences: Euler's totient - Fermat's, Euler's and Wilson's Theorems - Solutions of Congruences - The Chinese Remainder theorem

**UNIT III** **(15 Hours)**

Prime power Moduli -Prime modulus - Primitive roots and Power Residues.

**UNIT IV** **(15 Hours)**

Quadratic Residues - Quadratic Reciprocity - The Jacobi Symbol - Binary Quadratic Forms-Equivalence and Reduction of Binary Quadratic Forms.

**UNIT V** **(15 Hours)**

Greatest integer Function - Arithmetic Functions - The Mobius Inversion Formula - Diophantine Equations - The equation $ax + by = c$ - Simultaneous Linear Diophantine Equations- Pythagorean Triangles.

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, PPT, Video Lecture |
| **Assessment methods** | MCQ, Quiz Snap Test |

**Books for Study:**

1. Niven, I., Zuckerman, H.S., & Montgomery, H.L. (2004). *An Introduction to the Theory of Numbers*, (5th Ed.). John Wiley & Sons Inc.
   **Unit- I** *Chapter 1*
   **Unit- II** *Chapter 2: Sections 2.1 to 2.3 and*
   **Unit- III** *Chapter 2: Sections 2.6 to 2.8*
   **Unit- IV** *Chapter 3: Sections 3.1 to 3.5*
   **Unit- V** *Chapter 4: Sections 4.1 to 4.3 and Chapter 5: Sections 5.1 to5.3*

**Books for Reference:**

1. Jones, G.A., & Jones, M. J. (2005). *Elementary Number Theory.* Springer Verlag,
2. Burton, D.M. (2007). *Elementary Number Theory*, (6th Ed.). McGraw-Hill.
3. Andrews, G. (1971). *Theory of Numbers.* Saunders.
4. William, J. (1977). *Fundamentals of Number Theory,* Leveque, Addison-Wesley.

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=ljRdsuRQNpg
2. https://www.youtube.com/watch?v=xsePkxUjhiU&list=PLmxCweM-UENwnMm2Q7kPSzRmVN-u2mvMZ&index=1
3. https://www.youtube.com/watch?v=L4UXz1qteOY

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K - Level)** |
| **CO1** | Have knowledge of divisibility, prime numbers, congruences, quadratic reciprocity and Diophantine equations. | **K1** |
| **CO2** | Understand the concept of number theory toper form numerical and symbolic computations. | **K2** |
| **CO3** | Solve problems and give short proofs associated with prime numbers, divisors, modulo arithmetic, primitive Roots and quadratic residues. | **K3** |
| **CO4** | Analyze the theory of congruences, Power Residues, The Jacobi Symbol, The Mobius Inversion Formula and linear Diophantine equations. | **K4** |
| **CO5** | Evaluate and produce rigorous arguments centered on the material of number theory, most notably in the use of mathematical Induction and/or the Well Ordering Principal in the proof of theorems. | **K5** |
| **CO6** | Construct and produce rigorous arguments centered on the material of number theory in the proof of theorems. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **3** | **25PMA3CC12** | | | **Core Course - 12:** Algebraic Number Theory | | | | | | **5** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | **2.2** |
| **CO2** | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | **2.1** |
| **CO3** | 1 | 2 | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 2 | **2.2** |
| **CO4** | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | **2.2** |
| **CO5** | 2 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | **2.5** |
| **CO6** | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | **2.2** |
| | | | | | | | | | | **Mean Overall Score** | **2.23 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 3 | 25PMA3ES02A | **Discipline Specific Elective - 2:** Numerical Analysis | 4 | 3 |

| Course Objectives |
|---|
| To solve transcendental and polynomial equations using iterative numerical methods. |
| To solve systems of linear equations and eigenvalue problems using direct and iterative numerical techniques. |
| To approximate functions and data using interpolation and least squares methods. |
| To perform numerical differentiation and integration using various methods. |
| To solve ordinary differential equations using numerical methods. |

**UNIT I** **(12 Hours)**

Transcendental and polynomial equations: Iteration Methods based on Second degree equation - Rate of convergence of iterative methods - Polynomial equations - Birge-Vieta method, Bairstow's method.

**UNIT II** **(12 Hours)**

System of Linear Algebraic equations and Eigen Value Problems: Direct Methods - Gauss Jordan Elimination Method - Triangularization method - Cholesky method - Error Analysis- Iteration Methods - Jacobi iteration method - Gauss - Seidel iteration method - Eigenvalues and Eigen vectors.

**UNIT III** **(12 Hours)**

Interpolation, Approximation and Differentiation: - Introduction - Hermite Interpolations- Piecewise and Spline Interpolation - Approximation - Least square approximation-

**UNIT IV** **(12 Hours)**

Differentiation and Integration: Numerical Differentiation - Optimum choice of Step length - Extrapolation methods. Numerical Integration: Methods based on undetermined coefficients - Gauss Legendre Integration method and Lobatto Integration Methods only.

**UNIT V** **(12 Hours)**

Ordinary differential equations: Introduction - Numerical Methods- Local truncation error - Euler, Backward Euler, Taylor's Method and second order Runge-Kutta method

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, Lectures, Demonstrations, PPT. |
| **Assessment Methods** | MCQ, Quiz & Snap Test |

**Books for Study:**

1. Jain, M.K., Iyengar, S.R.K., & Jain, R.K. (2003). Numerical Methods for Scientific and Engineering Computation, (7th Ed.). New Age International.
   Unit I: Chapter 2 (Sec 2.3 to 2.7, 2.9)
   Unit II: Chapter 3 (Sec 3.2 to 3.5)
   Unit III: Chapter 4 (Sec 4.5 to 4.9)
   Unit IV: Chapter 5 (Sec 5.2 to 5.4), (Sec 5.6 to 5.8)
   Unit V: Chapter 6 (Sec 6.2 to 6.4)

**Books for Reference:**

1. Kendall E. Atkinson, An Introduction to Numerical Analysis, II Edn., John Wiley & Sons, 1988.
2. M.K. Jain, Numerical Solution of Differential Equations, 4th edn., New Age International Pvt Ltd., 2018.
3. Samuel. D. Conte, Carl. De Boor, Elementary Numerical Analysis; An Algorithmic Approach (Updated with MatLab), SIAM, 2018.
4. George A. Anastassiou, Razvan A. Mezei, Numerical Analysis Using Sage, Springer (UTM), 2016

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=6Evgu9JPJYA
2. https://www.youtube.com/watch?v=Lp2MdAvk2MY
3. https://www.youtube.com/watch?v=-YFXPVTX9V4&list=PLOzRYVm0a65d0WWST6wvOP6m7VRQyRgSa&index=24

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K - Levels)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Recall the definitions of key numerical methods and related terminology. | **K1** |
| **CO2** | Explain the principles behind different numerical methods and their applicability. | **K2** |
| **CO3** | Apply appropriate numerical methods to solve specific mathematical problems. | **K3** |
| **CO4** | Compare the accuracy and efficiency of different numerical methods for a given problem. | **K4** |
| **CO5** | Evaluate the results obtained from numerical methods and assess their reliability. | **K5** |
| **CO6** | Develop and modify numerical algorithms to solve complex engineering problems. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Title of the Course** | | | | | | | | **Hours** | **Credits** |
| **3** | **25PMA3ES02A** | **Discipline Specific Elective - 2:** Numerical Analysis | | | | | | | | **4** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | **2.5** |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | **2.3** |
| **CO3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | **2.3** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | **2.6** |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO6** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| | | | | | | | | | | **Mean Overall Score** | **2.42(High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 3 | 25PMA3ES02B | **Discipline Specific Elective - 2:** Optimization Techniques | 4 | 3 |

| Course Objectives |
|---|
| To explain the concepts and to simultaneously develop an understanding of problem Solving methods |
| To study the basic components of an optimization problem. |
| Formulation of design problems as mathematical programming problems |
| To highlight some of the Applications of the optimization techniques |
| To impart Optimization Techniques |

**UNIT I** **(12 Hours)**

Optimization of functional - Gateaux and Fréchet Differentials - Fréchet derivatives - Extrema-Euler - Lagrange Equations- Problems with variable end points.

**UNIT II** **(12 Hours)**

Convex and concave functionals - Conjugate convex, concave functional - Dual optimization problems- Min - Max theorem of game theory.

**UNIT III** **(12 Hours)**

Lagrange multiplier theorem - Inverse function theorem- Equality and Inequality constraints – Kuhn - Tucker theorem.

**UNIT IV** **(12 Hours)**

Methods of solving equations - Successive approximation - Newton's method - Descent methods- Steepest descent.

**UNIT V** **(12 Hours)**

Conjugate gradient method - Methods for solving constrained problems - Projection method -The Primal - Dual method - Penalty Functions.

| | |
|---|---|
| **Teaching Methodology** | Chalk and Talk, PPT, Video Lecture |
| **Assessment Methods** | Seminar, Quiz, Test |

**Books for Study:**

1. Luenberger, D.G. (1997). *Optimization by Vector Space Methods.* Wiley Professional Paperback series.
   **Unit - I** *(Sec7.1-7.6 Pages 169-184)*
   **Unit - II** *(Sec7.8, 7.10-7.13 Pages 190, 191,195-208)*
   **Unit - III** *(Sec9.1-9.4 Pages 239-253)*
   **Unit - IV** *(Sec10.1-10.5 Pages 271-289)*
   **Unit - V** *(Sec10.8-10.11 Pages 294-307)*

**Books for Reference:**

1. Dorney, C.N. (1986). *A Vector Space Approach to Models and Optimization.* Robert Krieger Publishing Co.
2. Mohan, C. & Deep, K. (2010). *Optimization Techniques.* New Age International.
3. Hamley, A. & Taha. (2011). *Operations Research: An introduction,* (19th Ed.). Prentice Hall.

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=Qodww3BcZZs
2. https://www.youtube.com/watch?v=1M8t6AXCyGk&t=132s
3. https://www.youtube.com/watch?v=V64HwFDLnoc

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K - Level)** |
| **CO1** | Relate the concepts of theory of optimization while solving problems. | **K1** |
| **CO2** | Understand the theory behind optimization techniques. | **K2** |
| **CO3** | Apply suitable theory in the optimal problem. | **K3** |
| **CO4** | Compare the uses of different theories and methods available. | **K4** |
| **CO5** | Evaluate the optimal solution for the given function. | **K5** |
| **CO6** | Create some new techniques for optimization | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **3** | **25PMA3ES02B** | | | **Discipline Specific Elective - 2:** Optimization Techniques | | | | | | **4** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | **2.1** |
| **CO2** | 2 | 3 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | **2.2** |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 1 | 2 | **2.3** |
| **CO4** | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | **2.1** |
| **CO5** | 3 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | **2.3** |
| **CO6** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 1 | 2 | **2.3** |
| | | | | | | | | | **Mean Overall Score** | | **2.2 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 3 | 25SCS3RM01 | Research Methodology | 4 | 2 |

| Course Objectives |
|---|
| To comprehend the fundamental concepts, objectives, significance, and challenges of research, along with techniques for defining research problems. |
| To understand the principles of research design, experimental design, and various sampling techniques for effective data collection. |
| To explore different methods of primary and secondary data collection and develop the ability to select appropriate data-gathering techniques. |
| To analyze and interpret research data using statistical measures, regression analysis, and correlation techniques. |
| To gain knowledge of Intellectual Property Rights (IPR), patents, and legal frameworks related to research innovations and their protection. |

**UNIT I: Basics of Research (12 Hours)**

Meaning of Research - Objectives - Motivation - Type of Research - Research Approaches - Significance- Research Methods Versus Methodology - Research and Scientific Method - Importance - Research Process - Criteria of Good Research - Problems Encountered by Researches in India. Defining the Research Problem: Research Problem - Selecting the Problem - Necessity of Defining the Problem - Technique Involved in Defining a Problem.

**UNIT II: Research Design (12 Hours)**

Meaning of a Research Design - Need for Research Design - Features of a Good Design - Important Concept Relating to Research Design - Different Research Design - Basic Principles of Experimental Design. Sampling Design: Census and Sample Survey - Implication of a Sample Design - Steps in Sampling Design - Criteria of Selecting a Sampling Procedure - Characteristics of a Good Sample Designs - Different Type of Sample Designs -Select a Random sample - Random Sample from an Infinite Universe - Complex Random Sampling Designs.

**UNIT III: Methods and Data Collection (12 Hours)**

Collection of Primary Data - Observation Method - Interview Method - Collection of Data Through Questionnaires - Collection of Data Through Schedules - Different Between Questionnaires and Schedules - Some Other Method of Data Collection - Collection of Secondary Data - Selecting of Appropriate Methods for Data Collection.

**UNIT IV: Processing and Analysis of Data (12 Hours)**

Processing Operations - Some Problems in Processing - Elements Type of Analysis - Statistics in Research - Measures of Central Tendency - Measures of Dispersion - Measures of Asymmetry (Skewness) - Measures of Relationships - Simple Regression Analysis - Multiple Correlation and Regression - Partial Correlation - Association in Case of Attributes - Other Measures.

**UNIT V: IPR and Patents (12 Hours)**

The need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design - Genetic Resources and Traditional Knowledge - Trade Secret - IPR in India: Genesis and development - IPR in abroad. Elements of Patentability: Novelty- Non Obviousness (Inventive Steps), Industrial Application - Non-Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentees.

| | |
|---|---|
| **Teaching Methodology** | Lectures, Flipped Classes. |
| **Assessment Methods** | MCQs, Snap Test. |

**Books for Study:**

1. Kothari C. R. (2004). *Research Methodology - Methods and Techniques*. (2nd Revised Ed.). New Age International Publishers.
   (Unit I- IV - Chapters: 1-4, 6,7.)

2. Nithyananda, K, V. (2019). Intellectual Property Rights: Protection and Management. Cengage Learning publisher.
(Unit V-Chapter: 1,2.)

**Books for Reference:**

1. David. Evans, Paul Gruba, Justin Zobel. (1995). *How to write a better thesis*. (3rd Ed.). Springer.
2. Neeraj, P, &Khusdeep, D. (2014). *Intellectual Property Rights. India.* PHI learning.

**Websites and eLearning Sources:**

1. https://www.scribbr.com/dissertation/thesis/
2. https://kostochk.web.illinois.edu/math412-10/
3. https://vemu.org/uploads/lecture_notes/18_01_2024_914828712.pdf

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Recall key research concepts, types of research, research methodologies, and intellectual property rights (IPR), including patents and copyrights. | **K1** |
| **CO2** | Explain the significance of research design, sampling methods, data collection techniques, and statistical measures used in research. | **K2** |
| **CO3** | Demonstrate the ability to formulate research problems, design research studies, and select appropriate data collection methods. | **K3** |
| **CO4** | Evaluate different research approaches, sampling techniques, and statistical tools to identify their relevance in solving research problems. | **K4** |
| **CO5** | Critically assess research findings, interpret data using statistical methods, and examine the impact of IPR laws on research and innovation. | **K5** |
| **CO6** | Develop well-structured research proposals, design experiments, and formulate strategies for protecting intellectual property rights. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | **Hours** | | **Credits** |
| **3** | **25SCS3RM01** | | | **Research Methodology** | | | | | **4** | | **2** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 2 | **2.4** |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 1 | 1 | **2.4** |
| **CO3** | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | **2.2** |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | **2.5** |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 1 | 1 | **2.4** |
| **CO6** | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **Mean Overall Score** | | | | | | | | | | | **2.4(High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 3 | 25PMA3SL03 | **Self-Learning:** History of Mathematics | - | 1 |

| Course Objectives |
|---|
| To trace the evolution of mathematical ideas across history. |
| To explore collaboration among mathematicians from different cultures and eras. |
| To identify key contributions of mathematicians to human development. |
| To analyse the cultural and historical context of mathematical discoveries. |
| To appreciate diverse perspectives and creative approaches in mathematics |

**UNIT I: The Ancient Greeks and Foundations of Mathematics**

The Ancient Greeks - Pythagoras - Introduction to Pythagorean Ideas - Euclid - Introduction to Euclid - Archimedes - The Genius of Archimedes-Zeno's Paradox and the Concept of Limit - The Context of the Paradox? - Consideration of the Paradoxes - Decimal Notation andLimits - Infinite Sums and Limits - Finite Geometric Series

**UNIT II: The Development of Algebra and Coordinate Geometry**

The Arabs and the Development of Algebra - The Development of Algebra AlKhowarizmi and the Basics of Algebra - The Life of Al-Khwarizmi - Omar Khayyam and the Resolutionof the Cubic - Cardano, Abel, Galois, and the Solving of Equations - A Particular Equation - The General Case - The Brief and Tragic Lives of Abel and Galois - The Work of Abel and Galois in Context - Rene Descartes and the Idea of Coordinates - Introductory Remarks -The Life of Rene Descartes - The Real Number Line - The Cartesian Plane -Coordinates in Three-Dimensional Space.

**UNIT III: Differential Calculus and Complex Numbers**

The Invention of Differential Calculus - The Life of Fermat - Fermat's Method-Fermat's Lemma and Maximum/Minimum Problems - Complex Numbers and Polynomials - Progenitors of the Complex Number System - Cardano - Argand - Cauchy - Riemann - Complex Number Basics - The Fundamental Theorem of Algebra - Finding the Roots of a Polynomial - Cauchy and the Foundations of Analysis - Why Do We Need the Real Numbers?

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**UNIT IV: Prime Numbers, Geometry, and Infinity**

The Prime Numbers - The Sieve of Eratosthenes - The Infinitude of the Primes - Dirichlet and How to Count - The Life of Dirichlet - The Pigeonhole Principle - Riemann and the Geometry of Surfaces - Introduction Georg Cantor and the Orders of Infinity -Introductory Remarks - An Uncountable Set - Countable and Uncountable - The Existence of Transcendental Numbers

**UNIT V: Modern Mathematics and Abstract Algebra**

Henri Poincare, Child Prodigy - Introductory Remarks - Emmy Noether and Algebra – The Life of Emmy Noether - Emmy Noether and Abstract Algebra: Groups - Emmy Noether and Abstract Algebra: Rings - The Idea of an Ideal - Cryptography - What is Cryptograpy

**Books for Study:**

1. Steven G. Krantz, *An Episodic History of Mathematics,* The Mathematical Association ofAmerica, 2010.
   **Unit I** *Sec: 1.1, 1.1.1, 1.2, 1.2.1, 1.3, 1.3.1, 2.1, 2.3, 2.4-2.6.*
   **Unit II** *Sec: 4.2, 4.2.1, 4.2.2, 4.2.4, 5.6, 5.7, 5.7.1, 5.7.2, 5.8.1, 5.9, 6.0-6.3, 6.5.*
   **Unit III** *Sec: 7.1, 7.2, 7.4, 8.2, 8.2.1-8.2.5, 8.3, 8.4, 8.5, 10.1, 10.2.*
   **Unit IV** *Sec: 11.1, 11.2, 12.1, 12.2, 13.0, 14.1, 14.2.1, 14.2.2, 14.3.*
   **Unit V** *Sec: 16.1, 18.1, 18.2, 18.3, 18.3.1, 20.3.*

**Books for Reference:**


1. C.B. Boyer and U. Merzbach, *History of Mathematics,* John Wiley & Sons, 3rd edition,2011.
2. E.T. Bell, *Men of Mathematics*, Published by Simon & Schuster, 1986.

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Explore the interconnections between different branches of mathematics (e.g., algebra, geometry, calculus) and how they evolved over time. | **K1** |
| **CO2** | Understand how mathematical concepts adapt and expand in response to new challenges and applications. | **K2** |
| **CO3** | Develop the ability to critically evaluate the structure and logic of mathematical arguments. | **K3** |
| **CO4** | Develop creative and flexible thinking by understanding that there are multiple ways to interpret and solve mathematical problems. | **K4** |
| **CO5** | Develop the ability to formulate abstract concepts and theories based on concrete instances. | **K5** |
| **CO6** | Demonstrate the ability to synthesize historical, theoretical, and practical aspects of mathematics in their work. | **K6** |

| Relationship Matrix | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | | **Hours** | **Credits** |
| **3** | **25PMA3SL03** | | | **Self-Learning:** History of Mathematics | | | | | | | **-** | **1** |
| **Course Outcomes** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | | |
| **CO1** | 1 | 2 | 3 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 2.2 | |
| **CO2** | 2 | 3 | 3 | 1 | 1 | 3 | 1 | 3 | 2 | 3 | 2.2 | |
| **CO3** | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 1 | 3 | 2.2 | |
| **CO4** | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 2.3 | |
| **CO5** | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 2.1 | |
| **CO6** | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 2.2 | |
| **Mean Overall Score** | | | | | | | | | | | 2.2 (High) | |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 4 | 25PMA4CC13 | **Core Course - 13:** Functional Analysis | 6 | 5 |

| Course Objectives |
|---|
| Introducing algebraic topology using norm on linear space |
| Understanding the Hahn Banach theorem and their consequences. |
| Application of uniform boundedness principle and related theorems |
| Concept of Orthogonality and Riesz theorem. |
| Concept of Banach Algebra and operators on Banach algebra |

**UNIT I** **(18 Hours)**

Normed Linear Spaces -Continuity of Linear Space -Operations and Norm -Schauder Basis - Continuity and Boundedness of Linear Mappings -Equivalent Norms -Finite Dimensional Normed Linear Spaces - Spaces of Bounded Linear Maps - Dual Spaces.

**UNIT II** **(18 Hours)**

Hahn-Banach Theorem - General Form - Complex Form - Continuous Extension Form - Second Dual and Natural Embedding - Reflexive Spaces - Dual of C[0,1]-The Conjugate of an Operator - Separation Form of Hahn-Banach Theorem.

**UNIT III** **(18 Hours)**

Uniform Boundedness Principle -Weak Convergence -The Open Mapping Theorem -The Closed Graph Theorem.

**UNIT IV** **(18 Hours)**

Inner Product Space and Hilbert Space - Parallelogram Law - Orthogonality -Orthonormal Sets

**UNIT V** **(18 Hours)**

Introduction to Banach Algebra -Adjoint of an Operator -Isometric Operator -Unitary Operator- Self-Adjoint Operator -Normal Operator - Projection Operator

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, group discussion, application and extension concepts. |
| **Assessment Method** | MCQ, Seminar, Written Test |

**Books for Study:**

1. Bose, S.C. (1992). *Introduction to Functional Analysis.* Mac Millan Publishers India, Delhi.
   **Unit-I** *Chapter 3(3.1-3.7)*
   **Unit-II** *Chapter 4(Sec4.0 -4.7)*
   **Unit-III** *Chapter5 (Sec: 5.0, 5.1,5.3 (pages 133-135) and Chapter 6(Sec 6.0,6.1,6, 3)*
   **Unit-IV** *Chapter 7 (sec 7.0- 7.6)*
   **Unit-V** *Chapter 8(sec 8.0-8.5)*

**Books for Reference:**

1. Somasundaram, D. (2008). *A First Course in Functional Analysis.* Narosa Book Distributors Private Ltd.
2. Simmons, G. F. (2006). *Introduction to Topology and Modern Analysis.* Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Rudin, W. (2006). *Functional Analysis.* Tata McGraw-Hill publishing Co. Ltd., New Delhi.

**Websites and eLearning Sources:**

1. http://www.math.nsc.ru/LBRT/g2/english/ssk/fa_e.pdf
2. https://people.math.ethz.ch/~salamon/PREPRINTS/funcana.pdf

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO Statements**<br>On successful completion of this course students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Acquire knowledge on certain linear topology such as normed linear spaces, Banach spaces, Hilbert spaces and inner product spaces. | **K1** |
| **CO2** | Understand the main properties of bounded operations between Banach and Hilbert spaces. | **K2** |
| **CO3** | Illustrate the duals of some normed linear spaces and the orthogonal sets by applying some specific techniques and apply important results | **K3** |
| **CO4** | Analyze the basic results associated to different types of convergence in normed linear spaces. | **K4** |
| **CO5** | Estimate the norm and convergence and bounds for functions and orthonormal basis | **K5** |
| **CO6** | Summarize the various concepts functional analysis to prove theorems and solve problems. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **4** | **25PMA4CC13** | | | **Core Course - 13:** Functional Analysis | | | | | | **6** | **5** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | **2.5** |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | **2.3** |
| **CO3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | **2.3** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | **2.6** |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO6** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| | | | | | | | | | | **Mean Overall Score** | **2.42 (High)** |

| Semester | Course Code | Title of the Course | Hours/Week | Credits |
|---|---|---|---|---|
| 4 | 25PMA4CC14 | **Core Course - 14:** Calculus of Variations and Integral Equations | 6 | 4 |

| Course Objectives |
|---|
| To know functionals and the construction of Euler's equation. |
| To understand variational methods for solving differential equations. |
| To analyze variational problems with moving boundaries. |
| To understand Green's function in reducing boundary value problems to integral equations. |
| To Know methods of finding infinite Fourier transforms and Fourier integrals. |

**UNIT I** **(18 Hours)**

The variation and its properties - Euler equation - Functionals involving derivatives of higherorder - Functionals depending on functions of several independent variables.

**UNIT II** **(18 Hours)**

Simplest problem with movable boundaries - Problems with movable boundaries - Extremalswith cups - One-sided variations - Mixed problems.

**UNIT III** **(18 Hours)**

Fields of extremals - The function E (x, y, p, y') - Ritz's method - Kantorovich's method.

**UNIT IV** **(18 Hours)**

Basic concepts - Relationship between Linear differential equations and Volterra integral equations - Resolvent kernel of Volterra integral equation - The method of successive approximation - Convolution type Equations - Volterra integral equation.

**UNIT V** **(18 Hours)**

Fredholm equations of second kind - Iterated kernels - Integral equations with degenerate kernels - Characteristic numbers and Eigenfunctions - Solution of homogeneous integral equations with degenerate kernels with separable kernels - Nonhomogeneous symmetric equations - Fredholm alternative.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models |
| **Assessment Methods** | Seminar, Snap Test, MCQ |

**Books for Study:**

1. Elsgolc, L.D. (2007). *Calculus of Variations.* Dover Publications, New York.
   **Unit-I** *Chapter 1 (Sec 1,2,3,4 and 5)*
   **Unit-II** *Chapter 2 (Sec 1,2,3,4,5 and 6)*
   **Unit-III** *Chapter 3 (Sec 1 and 2) and Chapter 5 (Sec 3 and 4)*
2. Krasnov. M., Kiselev. A., & Makarenko, G. (2018). *Problems and Exercise in Integrals Equations.* Manakin Press.
   **Unit- IV** *Chapter 1(Sec 1,2,3,4,5,6,7,8 and 11*)
   **Unit-V** *Chapter 2 (Sec 12,13,14,15,16,17,18 and 19)*

**Books for Reference:**

1. Krasnov. M., Kiselev, A., & Makarenko, G. (1971). *Problems and Exercise in Calculus of Variations*. MIR Publishers.
2. Francis. B., Hildebrand. (1968). *Methods of Applied Mathematics*, (2nd Ed.). Prentice - Hall ofIndia Pvt. Ltd. New Delhi.
3. Kanwal, R.P. (1971). *Linear Integral Equations - Theory and Techniques.* Academic press, New York.

**Websites and eLearning Sources:**

1. https://inria.hal.science/hal-03557517v1/document
2. https://en.wikipedia.org/wiki/Volterra_integral_equation
3. https://www.colorado.edu/amath/sites/default/files/attached-files/fredholm.pdf

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K - Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Describe the concepts viz, functional, variations and integralequations. | **K1** |
| **CO2** | Identify various methods in variations and integral equations. | **K2** |
| **CO3** | Understand the real life problem and find solution by applying suitable method | **K3** |
| **CO4** | Examine the existence of solution to a problem. | **K4** |
| **CO5** | Evaluate the extremal curves and determine the solution ofintegral equations. | **K5** |
| **CO6** | Formulate variation problem relevant to a real life situation. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **4** | **25PMA4CC14** | | | **Core Course - 14:** Calculus of Variations and Integral Equations | | | | | | **6** | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | **2.4** |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | **2.3** |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | **2.4** |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | **2.5** |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | **2.6** |
| **CO6** | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | **2.3** |
| | | | | | | | | | | **Mean Overall Score** | **2.4 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 4 | 25PMA4CC15 | **Core Course - 15:** Partial Differential Equations | 6 | 4 |

| Course Objectives |
|---|
| To have knowledge on to classify partial differential equations. |
| To have knowledge on solving different types of partial differential equations. |
| To explore the knowledge on applying first and second order partial differential equations in mathematical physics. |
| To have knowledge on analyze the solutions of partial differential equations. |
| To understand the concept of evaluating the solutions of second order partial differential equations elliptic, parabolic and hyperbolic |

**UNIT I** **(18 Hours)**

Partial differential equations - origins of first order partial differential equations - Cauchy's problem for first order equations - Linear equations of the first order Integral surfaces Passing through a given curve surfaces - Orthogonal to a given system of surfaces - Non linear partial differential equations of the first order.

**UNIT II** **(18 Hours)**

Cauchy's method of characteristics - compatible systems of first order equations - Charpit's method - Special types of first order equations - Solutions satisfying given condition - Jacobi's method.

**UNIT III** **(18 Hours)**

Partial differential equations of the second order. The origin of second order equations second order equations in Physics - Higher order equations in Physics - Linear partial differential equations with constant co-efficient-Equations with variable co-efficient-Characteristic curves of second order equations.

**UNIT IV** **(18 Hours)**

Characteristics of equations in three variables - The solution of Linear Hyperbolic equations - Separation of variables. The method of Integral Transforms - Non Linear equations of the second order.

**UNIT V** **(18 Hours)**

Laplace equation: Elementary solutions of Laplace's Equations - Families of equipotential Surfaces - Boundary value problems - Separation of variables - Problems with Axial Symmetry.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT |
| **Assessment Methods** | Seminar, Snap Test, MCQ |

**Books for Study:**

1. Sneddon, I.N. (2006). Elements of Partial Differential Equations. Dover Publication INC, New York.
   Unit-I Ch. II, Sec.1-7
   Unit-II Ch. II, Sec.8-13
   Unit-III Ch. III, Sec.1-6
   Unit-IV Ch. III, Sec.7-11
   Unit-V Ch. IV, Sec.2-6

**Books for Reference:**

1. Raisinghania, M.D. (2005). Ordinary and Partial Differential Equations. S. Chand &Co.
2. Sharma. J.N, Kehar Singh. (2000). Partial Differential Equations for Engineers and Scientists, Narosa Publishing House.
3. Sankara Rao. K. (2009). Introduction to Partial Differential Equations, PHI Learning Private Limited

**Websites and eLearning Sources:**

1. www.khanacademy.org
2. https://youtu.be/LZnRlOA1_2I

3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ
5. https://archive.nptel.ac.in/courses/115/106/115106086/

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Have knowledge to classify partial differential equations and solve linear and non-linear partial differential equations using various methods. | **K1** |
| **CO2** | Understand different methods of solving partial differential equations. | **K2** |
| **CO3** | Apply the first, second and higher order partial differential equations in mathematical physics. | **K3** |
| **CO4** | Formulate partial differential equations and analyze their solutions. | **K4** |
| **CO5** | Identify the three main classes of second order partial differential equations elliptic, parabolic and hyperbolic and evaluating their solutions. | **K5** |
| **CO6** | Construct the second order PDE in mathematical physics | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | | **Hours** | **Credits** |
| **4** | **25PMA4CC15** | | | **Core Course - 15:** Partial Differential Equations | | | | | | **6** | **4** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | **2.4** |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | **2.7** |
| **CO6** | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | **2.6** |
| | | | | | | | | | | **Mean Overall Score** | **2.53 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 4 | 25PMA4ES03A | **Discipline Specific Elective - 3:** Automata Theory | 4 | 3 |

| Course Objectives |
|---|
| To introduce the concept of finite automata, its types and familiarize in designing them. |
| To enlighten on the concept of regular expressions and its uses; acquaint on generating and recognizing languages; explore the Chomsky hierarchy; familiarize on the relation betweendifferent language classes. |
| To enlighten on the importance of ambiguity resolution in parsing; to introduce the conceptof pushdown automata and its relation with Context Free Grammars. |
| To introduce the concept of lexical analysis and comprehend its role in compiler designing. |
| To demonstrate on applying state minimization techniques, explore different parsingtechniques, acquaint on the role of parsers and familiarize in constructing parsers. |

**UNIT I** **(12 Hours)**

Finite Automata and Regular expressions - Definitions and examples - Deterministic and Nondeterministic finite Automata - Finite Automata with-$\epsilon$ −moves.

**UNIT II** **(12 Hours)**

Context free grammar - Regular expressions and their relationship with automation - Grammar - Ambiguous and unambiguous grammars - Derivation trees - Chomsky Normal form.

**UNIT III** **(12 Hours)**

Push down Automata - Definition and examples - Relation with Context free languages.

**UNIT IV** **(12 Hours)**

Finite Automata and lexical analysis - Role of a lexical analyzer - Minimizing the number of states of a DFA - Implementation of a lexical analyzer.

**UNIT V** **(12 Hours)**

Basic parsing techniques - Parsers - Bottom-up Parsers - Shift reduce - operator precedence - Top down Parsers - Recursive descent - Predictive parsers.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT |
| **Assessment Methods** | Seminar, Snap Test, MCQ |

**Books for Study:**

1. John E. Hopcroft and Jeffrey D. Ullman, *Introduction to Automata theory, Languages and Computations,* Narosa Publishing House, Chennai, 2000.
   **Unit- I** *Chapter 2 (Sec 2.1 -2.4)*
   **Unit- II** *Chapter 2 (Sec2.5) and Chapter 4(Sec4.1 -4.3,4.5)*
   **Unit-III** *Chapter 5 (Sec5.2, 5.3)*
2. Aho A.V. and Jeffrey D. Ullman, *Principles of Compiler Design*, Narosa Publishing House, Chennai, 2002.
   **Unit- IV** *Chapter 3 (Sec3.1 -3.8)*
   **Unit- V** *Chapter 5 (Sec 5.1 -5.5)*

**Books for Reference:**

1. Harry R. Lewis and Christos H. Papadimitriou, *Elements of the Theory of Computation,* Second Edition, Prentice Hall,1997.
2. Aho A. V., Monica S. Lam, Sethi R., Ullman J. D., *Compilers: Principles, Techniques, And Tools,* Second Edition, Addison-Wesley, 2007.

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=-aIRqNnUvEg&list=PL85CF9F4A047C7BF7
2. https://www.youtube.com/watch?v=7ZbDEfnYwAo

3. https://www.youtube.com/watch?v=0dxk2mvf2RM

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements**<br>On successful completion of this course, students will be able to | **Cognitive Levels (K-Level)** |
| **CO1** | Enhance their knowledge in Mathematical notions of computation, such as computability, decidability and reducibility of the theory of formal languages and automata. | **K1** |
| **CO2** | Perceive the techniques of computations including finite state automata, grammars and regular expressions and their relations. State automata, grammars and regular expressions and their relations. | **K2** |
| **CO3** | Design and explain finite automata without $\epsilon$ -moves, derivation trees, push down automata and the lexical analyzer to the compilers. | **K3** |
| **CO4** | Analyze and recognize the patterns of automata and grammars using regular expressions. | **K4** |
| **CO5** | Evaluate the basic parsing techniques in arithmetic manner. | **K5** |
| **CO6** | State and explain Normal Forms of Grammar and Parsing techniques and implement the stack applications. | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | **Title of the Course** | | | | | | | **Hours** | **Credits** |
| **4** | **25PMA4ES03A** | | **Discipline Specific Elective - 3:** Automata Theory | | | | | | | **4** | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2.4 |
| **CO2** | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2.3 |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2.4 |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2.5 |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2.6 |
| **CO6** | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2.3 |
| | | | | | | | | | | **Mean Overall Score** | **2.4 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 4 | 25PMA4ES03B | **Discipline Specific Elective - 3:** Programming in C++ | 4 | 3 |

| Course Objectives |
|---|
| Understand the fundamental concepts of C++ programming. |
| Learn various operations, functions, constructors, overloading, and inheritance. |
| Develop problem-solving skills using C++ programming. |
| Analyze the efficiency and complexity of C++ programs. |
| Apply C++ knowledge to design and implement programs. |
| Create C++ programs to solve real-world problems. |

**UNIT I** **(12 Hours)**

Introduction to C++ - Applications of C++ statements - structure of C++ programs - Tokens, keywords, identifiers, data types - symbolic constant - type compatibility - defining variables

**UNIT II** **(12 Hours)**

Operators in C++ - Manipulators - Type cast operator - Expressions - Operator Overloading - control structures - Main function - Function prototyping - call by reference - return by reference - inline functions - default arguments - constant arguments - Recursion - Function overloading

**UNIT III** **(12 Hours)**

Specifying a class - Defining member functions -Making an outside function inline - Nesting of member functions - Arrays within a class - Memory allocation for objects - Constructors- Parameterized constructors - Multiple constructors in a class - Constructors with default arguments

**UNIT IV** **(12 Hours)**

Dynamic initialization of objects - Copy constructor - Dynamic constructor - Destructors - Defining operator overloading - Overloading unary, binary operators

**UNIT V** **(12 Hours)**

Binary operators overloading using friends - Manipulation of strings using operators - Rules for overloading operators - Defining derived classes - Single Inheritance - Making a private member inheritable - Multilevel, Multiple, Hierarchical and Hybrid inheritance

**Note: Practical will be given as some of the internal components.**

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation |
| **Assessment Methods** | Seminar, Snap Test, MCQ |

**Books for Study:**

1. Balagurusamy E, *Object Oriented Programming With C++*, Sixth Edition TATA MC-GRAW HILL Publishers, 2014.
   **Unit -I** *Chapter 2 (Sec 2.1 -2.6), Chapter 3 (Sec 3.1 -3.13)*
   **Unit -II** *Chapter 3 (Sec 3.14 -3.25), Chapter 4 (Sec 4.1 - 4.10)*
   **Unit -III** *Chapter 5 (Sec 5.1 - 5.10), Chapter 6(Sec 6.1 - 6.5)*
   **Unit -IV** *Chapter 6(Sec6.6 - 6.8, 6.11), Chapter 7 (Sec 7.1 - 7.4)*
   **Unit - V** *Chapter 7 (Sec 7.5 - 7.8), Chapter 8 (Sec 8.1 - 8.8)*

**Books for Reference:**


1. Jayaram M A and Rajendra Prasad D S, *Object Oriented Programming With C++*, Himalaya Publishing House Pvt. Ltd, Mumbai, 2002.
2. Ravichandran D, *Programming With C++*, New York, Tata Mc-Graw Hill Publishers, 1999.

3. Maria Litvin and Gary Litvin, *Programming In C++*, Vikas Publishing House Pvt. Ltd., New Delhi**,** 2001.

**Websites and eLearning Sources:**

1. https://www.youtube.com/watch?v=pX6LufLso2M
2. https://www.youtube.com/watch?v=fc2SjmrP67A
3. https://www.youtube.com/watch?v=Fvb0dPTm3fk&list=PLLy_2iUCG87Ah844iZW3w3nzWSTA8KSZA&index=7

| **Course Outcomes** | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Recognize the concepts of object-oriented programming | **K1** |
| **CO2** | Summarize various types of operations, functions, constructors, overloading and inheritance | **K2** |
| **CO3** | Practice codes in C++ for solving problems | **K3** |
| **CO4** | Analyse the complexity of C++ programs using different techniques | **K4** |
| **CO5** | Apply the knowledge of C++ to design programs for solving problems | **K5** |
| **CO6** | Construct new C++ programs to solve real life problems | **K6** |

| **Relationship Matrix** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | | **Title of the Course** | | | | | **Hours** | | **Credits** |
| **4** | **25PMA4ES03B** | | | **Discipline Specific Elective -3**: Programming in C++ | | | | | **4** | | **3** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2.2 |
| **CO2** | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 2.1 |
| **CO3** | 1 | 2 | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 2 | 2.2 |
| **CO4** | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 2.2 |
| **CO5** | 2 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | 2.5 |
| **CO6** | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 3 | 2 | 2.1 |
| **Mean Overall Score** | | | | | | | | | | | **2.2 (High)** |

| Semester | Course Code | Title of the Course | Hours/ Weeks | Credits |
|---|---|---|---|---|
| 4 | 25PMA4CE01 | Comprehensive Examination | - | 2 |

| Course Objectives |
|---|
| To attain deep understanding of the concept of Group theory, Rings and the elements of Galois Theory. |
| To understand the concepts of Countable and uncountable sets, Metric spaces, Sequence and Series, Continuous functions and uniform convergence and thereby solving problems based on these topics. |
| To provide deeper understanding of Analytic functions and their properties, Complex integration and their properties. |
| To understand the important concepts of Topology and Functional Analysis. |
| To develop problem solving skills. |

**UNIT I: Algebra**

Groups - A Counting Principle-Homomorphism- Another Counting Principle -Sylow's theorem - Ideals and Quotient rings - Polynomial Rings - The elements of Galois Theory

**UNIT-II: Real Analysis**

Countable and Uncountable Sets - Metric Spaces -Cauchy Sequences -Series -Continuous functions - Infinite Limits and Limits at Infinity - Mean Value Theorems - Uniform Convergence - Power series.

**UNIT III: Complex Analysis**

Analytic Functions - Complex Integration - The integral formula - Zeroes and Poles - The Residue theorem - Evaluation of Definite Integrals - Power Series expansion.

**UNIT IV: Topology**

Basis for a topology - Continuous functions - The Metric Topology - Connectedness and Compactness -The Countability axioms - The Separation axioms -The Urysohn lemma

**UNIT V: Functional Analysis**

Normed Linear Spaces - Continuity and Boundedness of Linear Mappings - Dual Spaces -Hahn-Banach Theorem -Dual of C[0,1] -The Open Mapping Theorem -Inner Product Space and Hilbert Space - Riesz Representation Theorem.

| | |
|---|---|
| **Teaching Methodology** | Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation |
| **Assessment Methods** | Seminar, Snap Test, MCQ |

**Books for Study:**


1. Herstein, IN. (1992). Topics in Algebra. Wiley Eastern Limited, New Delhi.
2. Rudin, W. (1976). Principles of Mathematical Analysis, (3rd Ed.). McGraw-Hill International Book Company, New York.
3. Ahlfors, L.V. (2013). Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable, (3rd Ed.). Mac Millan Publishers India, Delhi.
4. Munkres, J.R. (2009). Topology, (2nd Ed.). PHI Learning Pvt Ltd., New Delhi,
5. Bose, S.C. (1992). Introduction to Functional Analysis. MacMillan Publishers India, Delhi.


**Books for Reference:**


1. Lang, S. (2002). Algebra, (3rd Ed.). Springer Graduate Texts in Mathematics, New York.
2. Apostol, T.M. (1974). Mathematical Analysis. Addison-Wesley Publishing Company.
3. Ponnusamy, S. (2005). "Foundations of Complex Analysis, (2nd Ed.). Narosa Publishing House.
4. Dugundji, J. (1966). Topology. Allyn & Bacon.
5. Simmons, G.F. (2006). Introduction to Topology and Modern Analysis, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

**Websites and eLearning Sources:**

1. https://www.khanacademy.org/math/algebra
2. http://tutorial.math.lamar.edu/Classes/CalcI/MeanValueTheorem.aspx
3. https://www.khanacademy.org/math/algebra/x2f8bb11595b61c86:complex
4. https://ocw.mit.edu/courses/mathematics/18-102-introduction-to-functional-analysis-spring-2021/

| Course Outcomes | | |
|---|---|---|
| **CO No.** | **CO-Statements** | **Cognitive Levels (K-Level)** |
| | On successful completion of this course, students will be able to | |
| **CO1** | Acquire the knowledge on basic concepts, definitions and ideas with examples in Algebra, Analysis, and Topology | **K1** |
| **CO2** | Understand basic mathematical concepts and computational skills | **K2** |
| **CO3** | Articulate mathematical concepts and use it in solving problems in Algebra, Analysis, and Topology | **K3** |
| **CO4** | Compare the concepts of various subjects in Mathematics | **K4** |
| **CO5** | Develop creativity in communicating and solving mathematical problems | **K5** |
| **CO6** | Solve problems in competitive examinations | **K6** |

| Relationship Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | | **Title of the Course** | | | | | | | **Hours** | **Credits** |
| **4** | **25PMA4CE01** | | **Comprehensive Examination** | | | | | | | **-** | **2** |
| **Course Outcomes** | **Programme Outcomes (POs)** | | | | | **Programme Specific Outcomes (PSOs)** | | | | | **Mean Score of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO1** | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | **2.4** |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | **2.5** |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | **2.7** |
| **CO6** | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | **2.6** |
| **Mean Overall Score** | | | | | | | | | | | **2.53 (High)** |