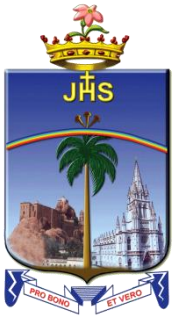
# M.Sc. MATHEMATICS

# LOCF SYLLABUS – 2021

## SCHOOLS OF EXCELLENCE

## WITH CHOICE BASED CREDIT SYSTEM (CBCS)




**DEPARTMENT OF MATHEMATICS**
**SCHOOL OF COMPUTING SCIENCES**
**ST. JOSEPH'S COLLEGE (AUTONOMOUS)**
Special Heritage Status Awarded by UGC
Accredited at $A^{++}$ Grade (IV Cycle) by NAAC
College with Potential for Excellence by UGC
DBT-STAR & DST-FIST Sponsored College
**Tiruchirappalli - 620 002, Tamil Nadu, India**

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

St. Joseph's College (Autonomous), a pioneer in higher education in India, strives to maintain and uphold the academic excellence. In this regard, it has initiated the implementation of five "Schools of Excellence" from the academic year 2014 – 15, to meet and excel the challenges of the 21st century.

Each School integrates related disciplines under one roof. The school system enhances the optimal utilization of both human and infrastructural resources. It also enhances academic mobility and enriches employability. The School system preserves the identity, autonomy and uniqueness of every department and reinforces Student centric curriculum designing and skill imparting. These five schools adhere to achieve and accomplish the following objectives.

Optimal utilization of resources both human and material for the academic flexibility leading to excellence.

Students experience or enjoy their choice of courses and credits for their horizontal mobility.

The existing curricular structure as specified by TANSCHE and other higher educational institutions facilitate the Credit-Transfer Across the Disciplines (CTAD) - a uniqueness of the choice based credit system.

Human excellence in specialized areas

Thrust in internship and / or projects as a lead towards research and

The multi-discipline nature of the School System caters to the needs of stake-holders, especially the employers.

**Credit system:**

Weightage to a course is given in relation to the hours assigned for the course. Generally one hour per week has one credit. For viability and conformity to the guidelines credits are awarded irrespective of the teaching hours. The credits and hours of each course of a programme is given in the table of Programme Pattern. However, there could be some flexibility because of practical, field visits, tutorials and nature of project work.

For PG courses, a student must earn a minimum of 110 credits as mentioned in the programme pattern table. The total number of minimum courses offered by the Department is given in the Programme Structure.

## OUTCOME-BASED EDUCATION (OBE)
## LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

**OBE** is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience, each student should have achieved the goal. There is no single specified style of teaching or assessment in OBE; instead, classes, opportunities and assessments should all help the students achieve the specific outcomes

Outcome Based Education, as the name suggests depends on Outcomes and not Inputs. The outcomes in OBE are expected to be measurable. In fact each Educational Institute can state its own outcomes. The ultimate goal is to ensure that there is a correlation between education and employability

**Outcome –Based Education (OBE):** is a student-centric teaching and learning methodology in which the course delivery, assessment are planned to achieve, stated objectives and outcomes. It focuses on measuring student performance i.e. outcomes at different levels.

**Some important aspects of the Outcome Based Education**

**Course:** is defined as a theory, practical or theory cum practical subject studied in a semester.

**Course Outcomes (COs):** are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.

**Programme:** is defined as the specialization or discipline of a Degree.

**Programme Outcomes (POs):** Programme outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

**Programme Specific Outcomes (PSOs):**

PSOs are what the students should be able to do at the time of graduation with reference to a specific discipline.

**Programme Educational Objectives (PEOs):** The PEOs of a programme are the statements that describe the expected achievement of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after Graduation.

**Some important terminologies repeatedly used in LOCF.**

Core Courses (CC)

A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course. These are the courses which provide basic understanding of their main discipline. In order to maintain a requisite standard certain core courses must be included in an academic program. This helps in providing a universal recognition to the said academic program.

Discipline Specific Elective Courses (DSE)

Elective course may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective (DSE). These courses offer the flexibility of selection of options from a pool of courses. These are considered specialized or advanced to that particular programme and provide extensive exposure in the area chosen; these are also more applied in nature.

DSE: Four courses are offered, one course in each semester.

**Note:** To offer **one DSE**, a minimum of two courses of equal importance / weightage is a must.

One DSE Course in semester two is offered as interdisciplinary/common course among the departments in a School (Common Core Course) at the PG level.

Generic Elective Courses

An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

Generic Elective courses are designed for the students of **other disciplines**. Thus, as per the CBCS policy, the students pursuing particular disciplines would have to opt Generic Elective courses offered by other disciplines, as per the basket of courses offered by the college. The scope of the Generic Elective (GE) Courses is positively related to the diversity of disciplines in which programmes are being offered by the college.

Two GE Courses are offered, one each in semesters II and III. The GE course offered in semester II is within the school level and the GE in semester III is Between Schools level

The Ability Enhancement Courses (AEC)

One Main discipline related Ability Enhancement Course for 3 credits is offered for a PG programme by the Department.

Skill Enhancement Courses (SECs)

These courses focus on developing skills or proficiencies in the student, and aim at providing hands-on training. Skill enhancement courses can be opted by the students of any other discipline, but are highly suitable for students pursuing their academic programme.

One SEC is offered in semester II as a compulsory course on Soft Skills, offered by the Department of Human Excellence, common to all the students of PG programme.

Self–paced Learning: It is a course for two credits. It is offered to promote the habit of independent/self learning of Students. Since it is a two credit course, syllabus is framed to complete within 45 hours. It is not taught in the regular working hours.

**Comprehensive Examinations:** A detailed syllabus consisting of five units to be chosen from the courses offered over the five semesters which are of immense importance and those portions which could not be accommodated in the regular syllabus.

**Extra Credit Courses:** In order to facilitate the students, gaining knowledge/skills by attending online courses MOOC, credits are awarded as extra credits, the extra credit are at three semesters after verifying the course completion certificates. According to the guidelines of UGC, the students are encouraged to avail this option of enriching their knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals such as SWAYAM, NPTEL and etc.

**Course Coding:**

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

| 21 | PXX | N | XX | NN/NNX |
|---|---|---|---|---|
| Year of Revision | PG Department Code | Semester number. | Part Category | running number/with choice |

N:- Numerals X :- Alphabet

**Part Category**

CC - Core Theory

CP- Core Practical

**IS- Internship**

**SP- Self Paced Learning**

**CE- Comprehensive Examination**

**PW- Project Work & viva-voce**

**Electives Courses**

ES – Department Specific Electives

EG- Generic Electives

EC - Additional core Courses for Extra Credits (If any)*

**Ability Enhancement Courses**

AE – Ability Enhancement Course

SE – Skill Enhancement Course – Soft skills

CW - SHEPHERD & Gender Studies (Outreach)

## CIA AND SEMESTER EXAMINATION

**Continuous Internal Assessment (CIA):**

| **Distribution of CIA Marks** | |
|---|---|
| **Passing Minimum: 50 Marks** | |
| Library Referencing | 5 |
| 3 Components | 35 |
| Mid-Semester Test | 30 |
| End-Semester Test | 30 |
| CIA | 100 |

**MID-SEM & END-SEM TEST**

Centralised – Conducted by the office of COE

1. Mid-Sem Test & End-Sem Test: (2 Hours each); will have Objective and Descriptive elements; with the existing question pattern PART-A; PART-B; PART-C and PART D.
2. One of the CIA Component II/III for UG & PG will be of 15 marks and compulsorily a online objective multiple choice question type.
3. The online CIA Component must be conducted by the Department / faculty concerned at a suitable computer centre.
4. The one marks of PART-A of Mid-Sem and End-Sem Tests will comprise only: OBJECTIVE MULTIPLE CHOICE QUESTIONS.
5. The number of hours for the 5 marks allotted for Library Referencing/ work would be 30 hours per semester. The marks scored out of 5 will be given to all the courses (Courses) of the Semester.

**Duration of Examination must be rational**; proportional to teaching hours 90 minute-examination / 50 Marks for courses of 2/3 hours/week (all Part IV UG Courses) 3-hours examination for courses of 4-6 hours/week.

**Knowledge levels for assessment of Outcomes based on Blooms Taxonomy**

| S. No. | Level | Parameter | Description |
|---|---|---|---|
| 1 | K1 | Knowledge/Remembering | It is the ability to remember the previously learned |
| 2 | K2 | Comprehension/Understanding | The learner explains ideas or concepts |
| 3 | K3 | Application/Applying | The learner uses information in a new way |
| 4 | K4 | Analysis/Analysing | The learner distinguishes among different parts |
| 5 | K5 | Evaluation/Evaluating | The learner justifies a stand or decision |
| 6 | K6 | Synthesis /Creating | The learner creates a new product or point of view |

**WEIGHTAGE of K – LEVELS IN QUESTION PAPER**

| (Cognitive Level) | Lower Order Thinking | | | Higher Order Thinking | | | Total |
|---|---|---|---|---|---|---|---|
| K- LEVELS | K1 | K2 | K3 | K4 | K5 | K6 | % |
| **SEMESTER EXAMINATIONS** | 15 | 20 | 35 | 30 | | | **100** |
| **MID / END Semester TESTS** | 12 | 20 | 35 | 33 | | | **100** |

| QUESTION PATTERN FOR SEMESTER EXAMINATION | |
|---|---|
| **SECTION** | **MARKS** |
| **SECTION–A**<br>(No choice ,One Mark) **THREE** questions from each unit **(**15x1 =15) | **15** |
| **SECTION-B**<br>(No choice ,2-Marks) **TWO** questions from each unit (10x2 =20) | **20** |
| **SECTION-C**<br>(Either/or type) (7- Marks) **ONE** question from each unit (5x7 =35) | **35** |
| **SECTION-D**<br>(3 out of 5) (10 Marks) **ONE** question from each unit (3x10 =30) | **30** |
| **Total** | **100** |

| BLUE PRINT OF QUESTION PAPER FOR SEMESTER EXAMINATION | | | | | | | |
|---|---|---|---|---|---|---|---|
| **DURATION: 3. 00 Hours.** | | | | | | | **Max Mark : 100** |
| **K- LEVELS** / **SECTIONS** | **K1** | **K2** | **K3** | **K4** | **K5** | **K6** | **Total Marks** |
| **SECTION–A** (One Mark, No choice) (15x1 =15) | 15 | | | | | | **15** |
| **SECTION-B** (2-Marks, No choice) (10x2=20) | | 10 | | | | | **20** |
| **SECTION-C** (7- Marks) (Either/or type) (5x7=35) | | | 5 | | | | **35** |
| **SECTION-D** (10 Marks) (3 out of 5) (3x10=30) Courses having only **K4** levels | | | | 3 | | | **30** |
| Courses having **K4** and **K5** levels **One K5 level question is compulsory** | | | | 2 | 1 | | |
| **(**Courses having **all the 6** cognitive levels **One K5 and K6 level questions can be compulsory** | | | | 1 | 1 | 1 | |
| **Total** | **15** | **20** | **35** | **30** | | | **100** |

| QUESTION PATTERN FOR MID/END TEST | | |
|---|---|---|
| **SECTION** | | **MARKS** |
| **SECTION–A** (No choice, One Mark) | (7x1 =7) | **7** |
| **SECTION-B** (No choice , 2-Marks) | (6x2 =12) | **12** |
| **SECTION-C** (Either/or type) (7- Marks) | (3x7 =21) | **21** |
| **SECTION-D** (2 out of 3) (10 Marks) | (2x10=20) | **20** |
| | **Total** | **60** |

| BLUE PRINT OF QUESTION PAPER FOR MID/END TEST | | | | | | | |
|---|---|---|---|---|---|---|---|
| **DURATION: 2. 00 Hours.** | | | | | | | **Max Mark: 60.** |
| **K- LEVELS** / **SECTIONS** | **K1** | **K2** | **K3** | **K4** | **K5** | **K6** | **Total Marks** |
| **SECTION –A** (One Mark, No choice) (7 x 1 = 7) | 7 | | | | | | **07** |
| **SECTION-B** (2-Marks, No choice) (6 x 2 = 12) | | 6 | | | | | **12** |
| **SECTION-C** (Either/or type) (7-Marks ) (3 x 7 =21) | | | 3 | | | | **21** |
| **SECTION-D** (2 out of 3) (10 Marks) (2x10=20) Courses having only **K4** levels | | | | 2 | | | **20** |
| Courses having **K4** and **K5** levels **One K5 level question is compulsory** | | | | 1 | 1 | | |
| Courses having **all the 6** cognitive levels **One K6 level question is compulsory** | | | | | 1 | 1 | |
| Total Marks | **07** | **12** | **21** | **20** | | | **60** |
| Weightage for 100 % | **12** | **20** | **35** | **33** | | | **100** |

**Assessment pattern for two credit courses.**

| S. No. | Course Title | CIA | Semester Examination | Total Marks |
|---|---|---|---|---|
| 1 | Self Paced Learning Course | 25 + 25 = 50 | 50 Marks MCQ ( COE) | 100 |
| 2 | Comprehensive Examinations | 25 +25 = 50 | 50 Marks (MCQ) (COE) | 100 |
| 3 | Internship | 100 | -- | 100 |
| 4 | Field Visit | 100 | -- | 100 |
| 5 | Ability Enhancement Course (AEC) for PG (3 credits) | 50 (Three Components) | 50 (COE) Specific Question Pattern | 100 |
| **Assessment Pattern for Courses in Part - IV** | | | | |
| 6 | Value Education Courses and Environmental Studies | 50 | 50 Marks (For 2.00 hours) ( COE) | 100 |
| 7 | Skill Enhancement Courses(SECs) | 50 marks (by Course in-charge) 50 Marks ( by an External member from the Department) | | 100 |
| 8 | SEC: SOFT SKILLS ( For UG and PG) | 100 | (Fully Internal) | 100 |

## EVALUATION

### GRADING SYSTEM

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added and converted as final mark. The marks thus obtained will then 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 (GPA) and Cumulative Grade Point Average (CGPA) respectively. These two are calculated by the following formulae:

| | |
|---|---|
| $GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$ | $WAM\,(Weighted\,Average\,Marks) = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$ |
| Where, $C_i$ is the Credit earned for the Course i<br>$G_i$ is the Grade Point obtained by the student for the Course i<br>$M_i$ is the marks obtained for the course i and<br>n is the number of Courses **Passed** in that semester. | |

**CGPA:** Average GPA of all the Courses starting from the first semester to the current semester.

**CLASSIFICATION OF FINAL RESULTS:**

i) The classification of final results shall be based on the CGPA, as indicated in Table-2.

ii) For the purpose of Classification of Final Results, the candidates who earn the CGPA 9.00 and above shall be declared to have qualified for the Degree as 'Outstanding'. Similarly the candidates who earn the CGPA between 8.00 and 8.99, 7.00 and 7.99, 6.00 and 6.99 and 5.00 and 5.99 shall be declared to have qualified for their Degree in the respective programmes as 'Excellent', 'Very Good', 'Good', and 'Above Average' respectively.

iii) A Pass in SHEPHERD will continue to be mandatory although the marks will not count for the calculation of the CGPA.

iv) Absence from an examination shall not be taken an attempt.

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

| Marks 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: Final Result**

| CGPA | Corresponding Grade | Classification of Final Result |
|---|---|---|
| 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** |
| 5.0 0 to 5.99 | **B** | **Above Average** |
| Below 5.00 | **RA** | **Re-appearance** |

Credit based weighted Mark System is adopted for the individual semesters and cumulative semesters in the column 'Marks secured' (for 100)

**Declaration of Result**

Mr./ MS. _____ has successfully completed the Post Graduate in _____ programme. The candidate's Cumulative Grade Point Average (CGPA) is _____ and the class secured is _____ by completing the minimum of 110 credits.

The candidate has also acquired _____ (if any) extra by attending MOOC courses.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

The Programme Outcomes(POs)/Programme Specific Outcomes(PSOs) are the qualities that must be imbibed in the graduates by the time of completion of their programme. At the end of each programme the PO/PSO assessment in done from the CO attainment of all curriculum components. The POs/PSOs are framed based on the guidelines of LOCF. There are five POs UG programme and five POs for PG programme framed by the college. PSOs are framed by the departments and they are five in numbers.

For each Course, there are five Course Outcomes to be achieved at the end of the course. These Course outcomes are framed to achieve the POs/PSOs. All course outcomes shall have linkage to POs/PSOs in such a way that the strongest relation has the weight 3 and the weakest is 1. This relation is defined by using the following table.

| Mapping | <40% | ≥ 40% and < 70% | ≥ 70% |
|---|---|---|---|
| Relation | Low Level | Medium Level | High Level |
| Scale | 1 | 2 | 3 |

| **Mean Scores of COs =** $\frac{\text{Sum of values}}{\text{Total No.of POs \& PSOs}}$ | | **Mean Overall Score =** $\frac{\text{Sum of Mean Scores}}{\text{Total No.of COs}}$ | |
|---|---|---|---|
| **Result** | **Mean Overall Score** | **< 1.2** | **# Low** |
| | | **≥ 1.2 and < 2.2** | **# Medium** |
| | | **≥ 2.2** | **# High** |

If the mean overall score is low then the course in charge has to redesign the particular course content so as to achieve high level mean overall score.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

The Programme Outcomes (POs)/Programme Specific Outcomes(PSOs) are the qualities that must be imbibed in the graduates by the time of completion of their programme. At the end of each programme the PO/PSO assessment in done from the CO attainment of all curriculum components. The POs/PSOs are framed based on the guidelines of LOCF. There are five POs UG programme and five POs for PG programme framed by the college. PSOs are framed by the departments and they are five in numbers.

For each Course, there are five Course Outcomes to be achieved at the end of the course. These Course outcomes are framed to achieve the POs/PSOs. All course outcomes shall have linkage to POs/PSOs in such a way that the strongest relation has the weight 3 and the weakest is 1. This relation is defined by using the following table.

| Mapping | <40% | ≥ 40% and < 70% | ≥ 70% |
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| Scale | 1 | 2 | 3 |

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|---|---|---|---|
| **Result** | **Mean Overall Score** | **< 1.2** | **# Low** |
| | | **≥ 1.2 and < 2.2** | **# Medium** |
| | | **≥ 2.2** | **# High** |

If the mean overall score is low then the course in charge has to redesign the particular course content so as to achieve high level mean overall score.

## 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 (PEO)

- Graduates will be able to accomplish professional standards in the global environment.
- Graduates will be able to uphold integrity and human values.
- 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 solutions 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 professionals and entrepreneurs upholding human values.
5. Graduates groomed with ethical values and social concern will be able to understand and appreciate cultural diversity, promote 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** | | | | | |
| **Sem.** | **Specification** | **No. of Courses** | **No. of Hours** | **Credits** | **Total Credits** |
| I-IV | Core Courses: Theory | **13** | **76** | **69** | **69** |
| II | Self - Paced Learning | 1 | - | **2** | **2** |
| IV | Comprehensive Examination | 1 | - | **2** | **2** |
| IV | Project Work & Viva Voce | 1 | 8 | **5** | **5** |
| I- IV | Discipline Specific Elective | 4 | 20 | **16** | **16** |
| III | AbilityEnhancement Course | 1 | 4 | **3** | **3** |
| II | Skill Enhancement Course (Soft Skills) | 1 | 4 | **3** | **3** |
| II | Generic Elective IDC (WS) | 1 | 4 | **3** | **3** |
| III | Generic Elective IDC (BS) | 1 | 4 | **3** | **3** |
| II - IV | Online Courses (MOOC) | 3 | - | **(6)** | **(6)** |
| **I-IV** | **Outreach Programme** | **-** | **-** | **4** | **4** |
| | **Total** | | **120** | **110(6)** | **110(6)** |

| M. Sc. MATHEMATICS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PROGRAMME PATTERN** | | | | | | | |
| **Course Details** | | | | | **Scheme of Exams** | | |
| **Sem** | **Course Code** | **Course Title** | **Hrs** | **Cr** | **CIA** | **SE** | **Final** |
| I | 21PMA1CC01 | Algebra | 7 | 6 | 100 | 100 | 100 |
| | 21PMA1CC02 | Real Analysis – I | 6 | 5 | 100 | 100 | 100 |
| | 21PMA1CC03 | Graph Theory | 6 | 5 | 100 | 100 | 100 |
| | 21PMA1CC04 | Classical Dynamics | 6 | 5 | 100 | 100 | 100 |
| | 21PMA1ES01A | **DSE – 1:** Stochastic Processes | 5 | 4 | 100 | 100 | 100 |
| | 21PMA1ES01B | **DSE – 1:** Differential Geometry | | | | | |
| | | **Total** | **30** | **25** | | | |
| II | 21PMA2CC05 | Linear Algebra | 6 | 5 | 100 | 100 | 100 |
| | 21PMA2CC06 | Real Analysis – II | 4 | 4 | 100 | 100 | 100 |
| | 21PMA2CC07 | Complex Analysis | 7 | 6 | 100 | 100 | 100 |
| | 21SCS2ES02 | **DSE – 2:** Design and Analysis of Algorithms | 5 | 4 | 100 | 100 | 100 |
| | 21PMA2SP01 | **Self -Paced Learning:** History of Mathematics | - | 2 | 50 | 50 | 50 |
| | 21PSS2SE01 | **SEC:** Soft skills | 4 | 3 | 100 | - | 100 |
| | 21PMA2EG01 | **GE-1: (WS)** Mathematical Foundations | 4 | 3 | 100 | 100 | 100 |
| | 21PCA2EG01 | **GE-1: (WS)** Applied Statistics using R | | | | | |
| | 21PCS2EG01 | **GE-1: (WS)** Mobile Adhoc Networks (MANET) | | | | | |
| | | Extra Credit Courses (MOOC)-1 | - | (2) | | | |
| | | **Total** | **30** | **27 (2)** | | | |
| III | 21PMA3CC08 | Measure and Integration | 6 | 6 | 100 | 100 | 100 |
| | 21PMA3CC09 | Topology | 6 | 5 | 100 | 100 | 100 |
| | 21PMA3CC10 | Ordinary Differential Equations | 5 | 5 | 100 | 100 | 100 |
| | 21PMA3ES03A | **DSE -3:** Algebraic Number Theory | 5 | 4 | 100 | 100 | 100 |
| | 21PMA3ES03B | **DSE- 3:** Optimization Techniques | | | | | |
| | 21PMA3AE01 | **AEC:** Problem solving in Advanced Mathematics | 4 | 3 | 50 | 50 | 50 |
| | 21PMA3EG02 | **GE-2: (BS)** Operations Research | 4 | 3 | 100 | 100 | 100 |
| | | Extra Credit Courses (MOOC)-2 | | (2) | | | |
| | | **Total** | **30** | **26 (2)** | | | |
| IV | 21PMA4CC11 | Functional Analysis | 6 | 6 | 100 | 100 | 100 |
| | 21PMA4CC12 | Partial Differential Equations | 5 | 5 | 100 | 100 | 100 |
| | 21PMA4CC13 | Calculus of Variations, Integral Equations and Integral Transforms | 6 | 6 | 100 | 100 | 100 |
| | 21PMA4ES04A | **DSE – 4:** Automata Theory | 5 | 4 | 100 | 100 | 100 |
| | 21PMA4ES04B | **DSE – 4:** Programming in C++ | | | | | |
| | 21PMA4PW01 | Project work | 8 | 5 | 100 | 100 | 100 |
| | 21PMA4CE01 | Comprehensive Examination | - | 2 | 50 | 50 | 50 |
| | | Extra Credit Courses (MOOC)-3 | - | (2) | | | |
| | | **Total** | **30** | **28 (2)** | | | |
| I-IV | 21PCW4OR01 | Outreach Programme (SHEPHERD) | | 4 | | | |
| | | **Total** | **120** | **110(6)** | | | |

*The courses with a scheme of Exam 50 in CIA and SE will be converted to 100 for grading.

| GENERIC ELECTIVE -1: 2nd Semester<br>Within school (WS)- Offered to students belong to other Departments in the School | | | | | | | |
|---|---|---|---|---|---|---|---|
| Course Details | | | | | Scheme of Exams | | |
| School | Course Code | Course Title | Hrs | Cr | CIA | SE | Final |
| SBS | 21PBI2EG01 | Herbal Technology | 4 | 3 | 100 | 100 | 100 |
| | 21PBT2EG01 | Medical Biotechnology | 4 | 3 | 100 | 100 | 100 |
| | 21PBO2EG01 | Medicinal Botany | 4 | 3 | 100 | 100 | 100 |
| SCS | 21PCA2EG01 | Applied Statistics using R | 4 | 3 | 100 | 100 | 100 |
| | 21PMA2EG01 | Mathematical Foundations | 4 | 3 | 100 | 100 | 100 |
| | 21PCS2EG01 | Mobile Adhoc Networks (MANET) | 4 | 3 | 100 | 100 | 100 |
| SLAC | 21PEN2EG01A | Indian Literature in Translation | 4 | 3 | 100 | 100 | 100 |
| | 21PEN2EG01B | English Literature For Competitive Examinations | | | | | |
| SMS | 21PCO2EG01 | Supply Chain Management | 4 | 3 | 100 | 100 | 100 |
| | 21PEC2EG01 | Labour Economics | 4 | 3 | 100 | 100 | 100 |
| | 21PHR2EG01 | Organizational Behaviour | 4 | 3 | 100 | 100 | 100 |
| | 21PCC2EG01 | Stress Management | 4 | 3 | 100 | 100 | 100 |
| SPS | 21PCH2EG01 | Industrial Products | 4 | 3 | 100 | 100 | 100 |
| | 21PPH2EG01A | Solar Energy and Utilization | 4 | 3 | 100 | 100 | 100 |
| | 21PPH2EG01B | Renewable Energy Resources | 4 | 3 | 100 | 100 | 100 |

| GENERIC ELECTIVE -2: 3rd Semester<br>Between schools (BS)- Offered to students in the Departments belong to other Schools<br>(Except the school offering the course) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Course Details | | | | | Scheme of Exams | | |
| School | Course Code | Course Title | Hrs | Cr | CIA | SE | Final |
| SBS | 21PBI3EG02 | First Aid Management | 4 | 3 | 100 | 100 | 100 |
| | 21PBT3EG02 | Food Technology | 4 | 3 | 100 | 100 | 100 |
| | 21PBO3EG02 | Horticulture and Landscaping | 4 | 3 | 100 | 100 | 100 |
| SCS | 21PCA3EG02 | Web Design | 4 | 3 | 100 | 100 | 100 |
| | 21PMA3EG02 | Operations Research | 4 | 3 | 100 | 100 | 100 |
| | 21PCS3EG02 | Advances in Computer Science | 4 | 3 | 100 | 100 | 100 |
| | 21PDS3EG02 | Deep Learning | 4 | 3 | 100 | 100 | 100 |
| SLAC | 21PEN3EG02 | English for Effective Communication | 4 | 3 | 100 | 100 | 100 |
| SMS | 21PCO3EG02 | Basics of Taxation | 4 | 3 | 100 | 100 | 100 |
| | 21PEC3EG02 | Managerial Economics | 4 | 3 | 100 | 100 | 100 |
| | 21PHR3EG02 | Counselling and Guidance | 4 | 3 | 100 | 100 | 100 |
| | 21PCC3EG02 | Dynamics of Human Behaviour in Business | 4 | 3 | 100 | 100 | 100 |
| SPS | 21PCH3EG02 | Health Science | 4 | 3 | 100 | 100 | 100 |
| | 21PPH3EG02A | Physics for Competitive Exam | 4 | 3 | 100 | 100 | 100 |
| | 21PPH3EG02B | Nano Science | 4 | 3 | 100 | 100 | 100 |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| I | 21PMA1CC01 | CORE - 1: ALGEBRA | 7 | 6 |

| CONo. | CO - Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| CO-1 | acquaint with the fundamental algebraic structures, namely Rings, Fields and Vector spaces, essential for further study of Algebra. | K1 |
| CO-2 | understand definitions and statements of theorems, formulating conjectures and analyzing them critically. | K2 |
| CO-3 | design and implement the concepts of homomorphism and isomorphism between groups and rings for solving different types of problems | K3 |
| CO-4 | utilize the class equation and Sylow's theorems to solve different related problems. | K4 |
| CO-5 | demonstrate capacity of illustration for mathematical reasoning through analyzing, proving and explaining concepts from field extensions and Galois theory | K5 &K6 |

**Unit-I** **(21 Hours)**

Normal subgroups and Quotient groups – Homomorphism – Conjugacy – Sylow's Theorem.

**Unit-II** **(21Hours)**

Ideals and Quotient rings – More Ideals and Quotient rings – The field of quotients of an Integral Domain – Euclidean rings – A particular Euclidean ring.

**Unit-III** **(21Hours)**

Polynomial Rings-Polynomials over the Rational Field – Polynomial Rings over commutative rings.

**Unit-IV** **(21 Hours)**

Field Extension – Extension Fields – Roots of Polynomials – More about roots.

**Unit-V** **(21 Hours)**

The elements of Galois Theory – Finite Fields.

**Book for Study**

1. I. N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, NewDelhi,1992.
   **Unit – I** *Chapter2 (Sec 2.6, 2.7, 2.11and2.12)*
   **Unit –II** *Chapter3(Sec3.4, 3.5, 3.6, 3.7and 3.8)*
   **Unit – III** *Chapter3(Sec3.9, 3.10 and 3.11)*
   **Unit – IV** *Chapter5 (Sec5.1, 5.3, 5.5)*
   **Unit – V** *Chapter5 (Sec5.6) and Chapter7(Sec 7.1)*

**Books for Reference**

1. Serge Lang, *Algebra*, Third Edition, Springer Graduate Texts in Mathematics, New York, 2002.

2. N. S. Gopala Krishnan, *University Algebra*, Second Edition, John Wiley & Sons (Asia) Pvt. Ltd., 1986.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | **Title of the Course** | | | | | | **Hours** | **Credit** |
|---|---|---|---|---|---|---|---|---|---|---|
| **I** | **21PMA1CC01** | | **CORE-1: ALGEBRA** | | | | | | **7** | **6** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2.5 |
| **CO-2** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | 2.3 |
| **CO-3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2.3 |
| **CO-4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.6 |
| **CO-5** | 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 | Credits |
|---|---|---|---|---|
| I | 21PMA1CC02 | CORE-2: REAL ANALYSIS – I | 6 | 5 |

| CO.No. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| CO-1 | gain knowledge of concepts of modern analysis such as convergence, continuity, completeness and compactness in the Euclidean space and more general metric spaces. | K1 |
| CO-2 | understand the limits and how they used in convergence properties of sequence and series, continuity and derivative of real functions. | K2 |
| CO-3 | apply the suitable tests to examine the convergent and divergent series. | K3 |
| CO-4 | 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 |
| CO-5 | evaluate the limits of functions, derivative of functions at a point and points of discontinuity. | K5 &K6 |

**Unit-I** **(18 Hours)**

Introduction – Ordered sets – Finite, Countable and Uncountable Sets - Metric Spaces - Compact Sets - Perfect Sets - Connected Sets.

**Unit-II** **(18 Hours)**

Convergent Sequences – Subsequences – Cauchy Sequences – Upper and Lower Limits – some Special sequences – Series – Series of non-negative terms – the number *e*.

**Unit-III** **(18 Hours)**

The Root and Ratio Tests – Power Series – Summation by parts – Absolute convergence.

**Unit-IV** **(18 Hours)**

Limits of Functions – Continuous functions – Continuity and compactness continuity and Connectedness – Discontinuities – Monotone functions – Infinite Limits and Limits at Infinity.

**Unit-V** **(18 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.

**Book for Study**

1. Walter Rudin, *Principles of Mathematical Analysis,*Third Edition, McGraw-Hill International Book Company, NewYork, 1976.
   **Unit – I** *Chapter 1(Sec 1.0-1.11), Chapter 2.*
   **Unit – II** *Chapter 3(Sec 3.31-3.32)*
   **Unit – III** *Chapter 3(Sec 3.33-3.46)*

**Unit – IV** *Chapter 4*
**Unit – V** *Chapter 5 (Sec 5.1-5.15)*

**Books for Reference**

1. Tom M.Apostol, *Mathematical Analysis*, Addison-Wesley Publishing Company London, 1974.
2. Richard R. Goldberg, *Methods of Real Analysis*, Oxford & IBH Publishing Company, New Delhi, 1970.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credit** |
|---|---|---|---|---|---|---|---|---|---|---|
| **I** | **21PMA1CC02** | | | **CORE – 2: REAL ANALYSIS-I** | | | | **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** | |
| **CO-1** | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2.3 |
| **CO-2** | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2.3 |
| **CO-3** | 1 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2.3 |
| **CO-4** | 3 | 1 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2.3 |
| **CO-5** | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2.3 |
| | | | | | | | | | **Mean Overall Score** | | 2.3 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **I** | **21PMA1CC03** | **CORE – 3: GRAPH THEORY** | **6** | **5** |

| CO No. | CO - Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | acquire in depth knowledge on vital concepts in graph theory. | **K1** |
| **CO-2** | understand the graphs, its types and on the theory of connectivity, colorings and planarity. | **K2** |
| **CO-3** | apply the imbibed knowledge on the concepts to categorize graphs. | **K3** |
| **CO-4** | analyze and infer properties of graphs and its associated concepts. | **K4** |
| **CO-5** | evaluate connectivity, chromatic numbers etc., and construct graphs with specific properties. | **K5 & K6** |

**Unit-I** **(18 Hours)**

Basic concepts – Subgraphs – Degrees of vertices – Paths and connectedness – Operations on graphs – Directed graphs: Basic concepts – Tournaments.

**Unit-II** **(18 Hours)**

Vertex cuts and Edge cuts – Connectivity and Edge–Connectivity – Trees: Definition, Characterization and Simple Properties – Counting the number of Spanning Trees – Cayley's formula.

**Unit-III** **(18 Hours)**

Vertex Independent sets and Vertex Coverings – Edge Independent sets – Matching's and Factors – Eulerian graphs – Hamiltonian graphs.

**Unit-IV** **(18 Hours)**

Vertex colorings – Critical graphs – Triangle-free graphs – Edge colorings of graphs – Chromatic polynomials.

**Unit-V** **(18 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 – Kuratowski's Theorem.

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

**Book for Study**

1. R. Balakrishnan, K. Ranganathan, *ATextbook of Graph Theory*,Springer (India) Private Limited, New Delhi, 2013.
   **Unit-I** *Chapter I(Sec1.1 - 1.4, 1.7), Chapter II(Sec 2.1, 2.2)*
   **Unit-II** *Chapter III(Sec 3.1, 3.2), Chapter IV(Sec 4.1, 4.3, 4. 4)*

**Unit-III** *Chapter V(Sec 5.1 - 5.3), Chapter VI(Sec 6.1, 6.2)*
**Unit-IV** *Chapter VII(Sec 7.1 - 7.4, 7.7)*
**Unit-V** *Chapter VIII(Sec 8.1 - 8.6)*

**Books for Reference**


1. J. A. Bondy, U. S. R. Murty**,** *Graph Theory with Applications,* Macmillan Press Ltd.,1976.
2. F. Harary, *Graph Theory***,** Addison – Wesley Publishing Company, Inc. 1969.
3. Gary Chartrand, Linda Lesniak, Ping Zhang, *Graphs and Digraphs,* CRC press, 2010.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|
| **I** | **21PMA1CC03** | | | **CORE – 3: GRAPH THEORY** | | | | **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** | |
| **CO-1** | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2.5 |
| **CO-2** | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2.5 |
| **CO-3** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.6 |
| **CO-4** | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2.5 |
| **CO-5** | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2.4 |
| | | | | | | | | | **Mean Overall Score** | | 2.5 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **I** | **21PMA1CC04** | **CORE – 4: CLASSICAL DYNAMICS** | **6** | **5** |

| CO No. | CO - Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | acquire knowledge about the mechanical system of particles. | **K1** |
| **CO-2** | explain the theory of Variational principles. | **K2** |
| **CO-3** | classify Lagrange's equation, Hamilton equation and Hamilton Jacobi Theory. | **K3** |
| **CO-4** | examine the existence of solution to a problem. | **K4 & K5** |
| **CO-5** | convert a real-life problem to a practical problems. | **K6** |

**Unit-I** **(18 Hours)**

The mechanical system - Generalized coordinates - Constraints- Virtual work - Energy and momentum.

**Unit-II** **(18 Hours)**

Derivation of Lagrange's equations - examples - Integrals of motion.

**Unit-III** **(18 Hours)**

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

**Unit-IV** **(18 Hours)**

Hamilton's principle, Hamilton equations, other variational principles.

**Unit-V** **(18 Hours)**

Hamilton's Principal function - The Hamilton - Jacobi equation, separability.

**Book for Study**

1. Donald T. Greenwood, *Classical Dynamics*, Prentice Hall of India Pvt. Ltd, New Delhi, 1985.
   **Unit-I** *Chapter I (Sec 1.1 - 1.5)*
   **Unit-II** *Chapter II (Sec 2.1 - 2.3)*
   **Unit-III** *Chapter III (Sec 3.1, 3.2, 3.4)*
   **Unit-IV** *Chapter IV (Sec 4.1 - 4.3)*
   **Unit-V** *Chapter V (Sec 5.1 - 5.3)*

**Books for Reference**

1. John L. Synge, Byron A. Griffith, *Principles of Mechanics*, Third Edition, McGraw-Hill Book, New York, 1959.
2. Herbert Goldstein, Charles P. Poole, John L. Safko, *Classical Mechanics*, Addison-Wesley Press Inc., 2002.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| I | 21PMA1CC04 | CORE – 4: CLASSICAL DYNAMICS | 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 | |
| CO-1 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2.5 |
| CO-2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2.5 |
| CO-3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.6 |
| CO-4 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2.5 |
| CO-5 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2.4 |
| | | | | | | | | | | Mean Overall Score | 2.5 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **I** | **21PMA1ES01A** | **DSE-1: STOCHASTIC PROCESSES** | **5** | **4** |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | gain the knowledge of stochastic models. | **K1** |
| **CO-2** | understand the concepts of Markov chains, Transient and recurrent states, Poisson process, Renewal process and Queueing process. | **K2** |
| **CO-3** | apply the stochastic models in real life probabilistic situations. | **K3** |
| **CO-4** | investigate the states of Markov chain, the probabilities of birth-death process and behavior of queuing models. | **K4 & K5** |
| **CO-5** | create methodology to solve stochastic problems. | **K6** |

**Unit-I** **(15 Hours)**

Stochastic processes – Specification of Stochastic processes – Stationary processes – Markov chain – Transition probabilities – Random walk – Higher transition probabilities.

**Unit-II:** **(15 Hours)**

Classification of states – Transient and recurrent states – Limiting behavior of finite irreducible chains.

**Unit-III:** **(15 Hours)**

Poisson process – Inter arrival time – Generalizations of Poisson process – Pure birth process – Yule – Furry process – Birth – Immigration process.

**Unit-IV** **(15 Hours)**

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

**Unit-V:** **(15 Hours)**

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

**Book for Study**

1. J. Medhi, *Stochastic Processes*, New Age International Publishers, Second Edition, New Delhi, 1994.
   **Unit-I** *Chapter 2 (Sec 2.1 - 2.3) and Chapter 3 (Sec 3.1,3.2)*
   **Unit-II** *Chapter 3 (Sec 3.4, 3.6)*
   **Unit-III** *Chapter 4 (Sec4.1,4.2.1, 4.3(omit 4.3.5-4.3.7))*
   **Unit-IV** *Chapter 6 (Sec 6.1.1-6.1.3,6.2(omit example 2(b)),6.3,6.5(omit 6.5.2))*
   **Unit-V** *Chapter 10 (Sec10.1,10.2(omit10.2.3.1),10.7(omitexamples7(a), 7(b)and Sec 10.7.3, 10.7.4))*

**Books for Reference**

1. U.Narayan Bhat, *Elements of Applied Stochastic Processes*, Second Edition, John Wiley & Sons, New York, 1972.
2. N.V.Prabhu, *Stochastic Processes*, Mac-Millan, NewYork
3. Sheldon M. Ross, *Stochastic Processes*, Second Edition, John Wiley & Sons, New York,1996.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | | | Title of the Course | | | | Hours | Credits |
|---|---|---|---|---|---|---|---|---|---|
| I | 21PMA1ES01A | | | DSE – 1: STOCHASTIC PROCESSES | | | | 5 | 4 |
| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | Mean Scores of COs |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 2.0 |
| CO-2 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 2.2 |
| CO-3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2.3 |
| CO-4 | 3 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2.3 |
| CO-5 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2.4 |
| | | | | | | | | | Mean Overall Score | | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| I | 21PMA1ES01B | DSE – 1: DIFFERENTIAL GEOMETRY | 5 | 4 |

| CONo. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| CO-1 | have the knowledge of surfaces and their various properties. | K1 |
| CO-2 | observe the interrelation between derivatives and Geometry. | K2 |
| CO-3 | apply the concept learned from Differential geometry in mechanic | K3 |
| CO-4 | analysethe analytical representation of normal, tangent place and develop surfaces | K4 |
| CO-5 | design mathematical models for some real life problems | K5 &K6 |

**Unit - l** **(15 Hours)**

Analytical representation – Arc length – Tangent – Oscillating plane – Torsion – Formulae forFrenet contact.

**Unit – II** **(15 Hours)**

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

**Unit – III** **(15 Hours)**

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

**Unit - IV** **(15 Hours)**

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

**Unit – V** **(15 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.

**Book for Study**

1. Dirk J. Struik, *Lectures on Classical Differential Geometry*, Addison Wesley Publishing Company, 1950.

**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.1-3.6)*

**Books for Reference**

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

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | | | Title of the Course | | | | Hours | Credits |
|---|---|---|---|---|---|---|---|---|---|
| I | 21PMA1ES01B | | | DSE - 1: DIFFERENTIAL GEOMETRY | | | | 5 | 4 |
| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | Mean Scores of COs |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2.3 |
| CO-2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2.2 |
| CO-3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2.4 |
| CO-4 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2.3 |
| CO-5 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2.4 |
| | | | | | | | | | Mean Overall Score | | 2.32 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **II** | **21PMA2CC05** | **CORE – 5: LINEAR ALGEBRA** | **6** | **5** |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | acquire knowledge about matrix elementary row operations, isomorphism of vector spaces, commutative rings, characteristic value and annihilating polynomials. | **K1** |
| **CO-2** | understand the Representations of Linear transformations by a matrix, echelon matrix, permutations and simultaneous triangulation, simultaneous diagonalization and Direct sum decompositions. | **K2** |
| **CO-3** | illustrate representation of linear transformation by matrices, prime factorization of polynomial and inverse of invertible matrix using determinants. | **K3** |
| **CO-4** | investigate the Properties of row reduced echelon matrices and inverse of matrix | **K4** |
| **CO-5** | evaluate the bases and dimensions of a vector spaces, characteristic values and construction of transpose of linear transformation. | **K5 & K6** |

**Unit-I** **(18 Hours)**

Systems of linear Equations – Matrices and Elementary Row operations – Row–reduced echelon Matrices – Matrix Multiplication – Invertible Matrices – Basis and Dimension. (Only revision of Vector spaces and subspaces).

**Unit-II** **(18 Hours)**

The algebra of linear transformations – Isomorphism of Vector Spaces – Representations of Linear Transformations by Matrices – Linear Functionals – The Double Dual –The Transpose of a Linear Transformation.

**Unit-III** **(18 Hours)**

The algebra of polynomials – Lagrange Interpolation – Polynomial Ideals – The prime factorization of a polynomial – Commutative rings – Determinant functions.

**Unit-IV** **(18 Hours)**

Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values - Annihilating polynomials,

**Unit-V** **(18 Hours)**

Invariant subspaces – Simultaneous triangulation and simultaneous Diagonalization Direct – sum Decompositions – Invariant Direct sums – Primary Decomposition theorem.

**Book for Study**

1. Kenneth Hoffman and Ray Alden Kunze, *Linear Algebra*, Second Edition, Prentice Hall of India Private Limited, New Delhi,1975.
   **Unit – I** *Chapter 1(Sec 1.2-1.6) and Chapter 2(Sec 2.3)*

**Unit – II** *Chapter3*

**Unit – III** *Chapter 4(Sec 4.1-4.5) and Chapter 5(Sec 5.1-5.2)*

**Unit – IV** *Chapter5 (Sec 5.3, 5.4) and Chapter 6(Sec 6.1-6.3)*

**Unit – V** *Chapter 6 (Sec 6.4-6.8)*

**Books for Reference**


1. Kumaresan, *Linear Algebra*: *A Geometric Approach*, Prentice-Hall of India Ltd, 2004.
2. V.Krishnamurthy, V.P.Mainra, J.L.Arora, *Introduction to Linear Algebra*, East West Press Ltd, 1985.
3. A.R.Rao, P.Bhimashankaram,*LinearAlgebra*, Second Edition,Tata McGraw Hill, 2000
4. Charles W. Curtis, *Linear Algebra: An introductory approach*,Springer Verlag, 1984.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|
| **II** | **21PMA2CC05** | | | **CORE – 5: LINEAR ALGEBRA** | | | | **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** | |
| **CO-1** | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 | 2 | 2.2 |
| **CO-2** | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2.2 |
| **CO-3** | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 3 | 2 | 2.3 |
| **CO-4** | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2.3 |
| **CO-5** | 3 | 2 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 2.3 |
| | | | | | | | | | **Mean Overall Score** | | 2.3 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **II** | **21PMA2CC06** | **CORE – 6: REAL ANALYSIS – II** | **4** | **4** |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | acquire knowledge of Riemann-Stieltjes Integrals, continuity and uniform convergence of series of functions. | **K1** |
| **CO-2** | understand the properties of integration and some special functions | **K2** |
| **CO-3** | identify the applications of integration, linear transformation and power series. | **K3** |
| **CO-4** | analyze the abstract ideas and various methods in mathematical analysis and apply them to practical problems. | **K4** |
| **CO-5** | construct mathematical proofs for basic results and evaluate problems on the concepts learned. | **K5 &K6** |

**Unit-I** **(12 Hours)**

Definition and Existence of the Integral-Properties of the integral-Integration and Differentiation-Integration of Vector-valued functions-Rectifiable curves.

**Unit-II** **(12 Hours)**

Discussion of Main Problem-Uniform Convergence-Uniform Convergence and Continuity-Uniform Convergence and Integration-Uniform Convergence and Differentiation

**Unit-III** **(12 Hours)**

Power series-The Exponential and Logarithmic Functions-The Trigonometric Functions-The Algebraic Completeness of the Complex Field.

**Unit-IV** **(12 Hours)**

Fourier series–Parseval's theorem-The Gamma function.

**Unit-V** **(12 Hours)**

Linear Transformations – Differentiation - The Contraction Principle-The Inverse Function Theorem- The Implicit Function Theorem.

**Book for Study**

1. Walter Rudin, *Principles of Mathematical Analysis*, Third Edition, McGraw-Hill International Book Company, New York, 1976.

**Unit I** *Chapter 6(Sec6.1-6.27)*
**Unit II** *Chapter 7(Sec7.1-7.18)*
**Unit III** *Chapter 8(Sec8.1- 8.8)*
**Unit IV** *Chapter 8 (Sec8.9 - 8.22)*
**Unit V** *Chapter 9(Sec9.1-9.29)*

**Books for Reference**

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

2. Richard R Goldberg, *Methods of Real Analysis*, Oxford &IBH Publishing Company, New Delhi, 1970.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|
| **II** | **21PMA2CC06** | | | **CORE – 6: REAL ANALYSIS – II** | | | | **4** | | **4** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1.5 |
| **CO-2** | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 1 | 1.8 |
| **CO-3** | 1 | 1 | 3 | 3 | 1 | 2 | 2 | 3 | 3 | 1 | 2 |
| **CO-4** | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 1.9 |
| **CO-5** | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 1.8 |
| | | | | | | | | | **Mean Overall Score** | | 1.8(Medium) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **II** | **21PMA2CC07** | **CORE – 7: COMPLEX ANALYSIS** | **7** | **6** |

| CO No. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| **CO-1** | have the knowledge and skills to explain the fundamental concepts of Analyticity, Complex integration and Harmonic Functions. | **K1** |
| **CO-2** | understand the behavior of Analytic Functions, Taylor's and Laurent's Series expansions. | **K2** |
| **CO-3** | apply C-R equations, Residue Theorem in solving problems involving complex function theory. | **K3** |
| **CO-4** | demonstrate capacity for Mathematical reasoning through analyzing, proving and explaining concepts from Cauchy's Theorems. | **K4** |
| **CO-5** | evaluate integrals, region of convergence and contour integrals. | **K5 & K6** |

**Unit-I** **(21 Hours)**

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

**Unit-II** **(21 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** **(21 Hours)**

Cauchy's Integral Formula & Local Properties of Analytical Functions –The index of a point with respect to a closed curve –The integral formula – Higher Derivatives-Removable Singularities Taylor's Theorem – Zeroes and Poles – The Local Mapping.

**Unit-IV** **(21 Hours)**

The Calculus of Residues – The Maximum principle – The Residue theorem –The Argument principle – Evaluation of Definite Integrals –Definitions and Basic prosperities of Harmonic functions –The Mean Value Property.

**Unit-V** **(21 Hours)**

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

**Book for Study**

1. Lars V. Ahlfors, *Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable*, Third Edition, Mac Millan Publishers India, Delhi, 2013.
   **UNIT-I** *Chapter 2 (Sec 1.1-1.4, 2.4 & 2.5, Pages 21-33, 38-42)*
   **UNIT-II** *Chapter 4 (Sec 1.1-1.5, Pages101-114)*

**UNIT-III** *Chapter 4 (Sec 2.1-2.3, 3.1-3.3, Pages114–131)*
**UNIT-IV** *Chapter 4 (Sec 3.4, 5.1-5.3, 6.1 & 6.2, Pages133-137,148-166)*
**UNIT-V** *Chapter 4 (Sec 6.3& 6.4)*
*Chapter 5(Sec1.1-1.3, Pages166-172,175-186)*

**Books for Reference**


1. John B. Conway, *Functions of one Complex Variable,* Second Edition, Springer Graduate Texts in Mathematics, New York, 1978.
2. S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing
House, India, 2005.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|
| **II** | **21PMA2CC07** | | | **CORE – 7: COMPLEX ANALYSIS** | | | | **7** | | **6** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 3 | 2 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 2.3 |
| **CO-2** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2.2 |
| **CO-3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2.3 |
| **CO-4** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2.1 |
| **CO-5** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2.2 |
| | | | | | | | | | **Mean Overall Score** | | 2.22 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **II** | **21SCS2ES02** | **DSE – 2: DESIGN AND ANALYSIS OF ALGORITHMS** | **5** | **4** |

| CO.No. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | acquire the knowledge of data structures, design and analysis of algorithms | **K1** |
| **CO-2** | understand the data structures, design of computer algorithms with their complexity. | **K2** |
| **CO-3** | identify the complexity of algorithms and apply searching and sorting methods. | **K3** |
| **CO-4** | analyze the basic results of time complexity and space complexity in different types of algorithms. | **K4** |
| **CO-5** | evaluate the interpolation problems and create algorithms for data structures and computer algorithms using divide and conquer method, interpolation and sorting methods. | **K5 &K6** |

**Unit I (15 Hours)**

Introduction-Algorithm - Algorithm specification: Pseudocode Conventions, Recursive algorithms - Performance analysis: Space Complexity, Time Complexity, Asymptotic Notation.

**Unit II (15 Hours)**

Ordered lists – Polynomial addition – Representation of Arrays – Stack – Queue – Circular queue – Evaluation of Expressions – Infix to Postfix – Evaluation of Postfix.

**Unit III (15 Hours)**

Singly linked list –Linked stacks and queues –The storage pool – More on linked list - Doubly

Linkedlist (insertion and deletion only)- Tree- Binary tree representation – Binary tree traversals – Application of tree – Eight coins Decision tree.

**UnitIV (15 Hours)**

Divide and conquer – General method – Binary search- Finding the maximum and minimum in a set of items-Merge sort-Quick sort.

**UnitV (15 Hours)**

The Greedy Method – The General Method –Knapsack Problem – Job Sequencing with Deadlines - Backtracking-The 8-Queens problem-Algebraic problems-The general method-Evaluation and interpolation-Horner’s rule-Lagrange interpolation – Newtonian interpolation.

**Books for Study**

1. Ellis Horowitz, Sartaj Sahni and SanguthevarRajasekaran, *Fundamentals of Computer Algorithms*,Galgotia Publications Pvt.Ltd.,2004.
**Unit I** *Chapter 1(Sec1.1,1.2,1.3.1 - 1.3.3)*
**Unit IV** *Chapter 3(Sec3.1 - 3.5)*
**Unit V***Chapter 4 (Sec 4.1, 4.2, 4.4), Chapter 7 (Sec 7.2) and Chapter 9 (Sec 9.2)*

2. Ellis Horowitz, Sartaj Sahni, *Fundamentals of Data Structures*,Galgotia Book Source,1981.
**Unit II***Chapter 2(Sec2.2,2.4) and Chapter 3(Sec3.1,3.3)*
**Unit III** *Chapter4(Sec: 4.1,4.2,4.3,4.5, 4.8) and Chapter 5(Sec 5.1,5.2,5.3,5.4,5.8.2)*

**Books for Reference**


1. A.V. Aho, J.E. Hopcroft, J.D. Ullman, *The Design and Analysis of Computer Algorithms*, Addison-Wesley Publ.Comp., 1974.
2. Seymour E. Good man and S.T. Hedetniemi, *Introduction to the design and analysis of algorithms*,McGraw Hill International Edition, 2002.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| II | 21SCS2ES02 | DSE – 2: DESIGN AND ANALYSIS OF ALGORITHMS | 5 | 4 |

| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | | Mean Scores of COs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2.3 |
| CO-2 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2.3 |
| CO-3 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2.3 |
| CO-4 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2.4 |
| CO-5 | 2 | 2 | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 3 | 2.2 |
| | | | | | | | | | Mean Overall Score | | 2.3 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **II** | **21PMA2SP01** | **SELF-PACED LEARNING: HISTORY OF MATHEMATICS** | **-** | **2** |

| CONo. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| **CO-1** | acquire knowledge in history of mathematics and understand theinterrelations among the various branches of mathematics. | **K1 & K2** |
| **CO-2** | predict the dynamic nature of mathematics including recent development in pure and applied mathematics. | **K3** |
| **CO-3** | identify the various prooftechniques used in theorems. | **K4** |
| **CO-4** | assess creative and flexible thinking by studying historical evidence that there are different ways to view a mathematical concept. | **K5** |
| **CO-5** | construct abstract characterization of ideas from known examples. | **K6** |

**Unit-I**

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 and Limits - Infinite Sums and Limits - Finite Geometric Series.

**Unit-II**

The Arabs and the Development of Algebra - The Development of Algebra Al-Khowarizmi and the Basics of Algebra - The Life of Al-Khwarizmi - Omar Khayyam and the Resolution of 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**

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?

**Unit-IV**

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**

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 Cryptography?

**Book for Study**

1. Steven G. Krantz, *An Episodic History of Mathematics*, The Mathematical Association of America, 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.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | | | Title of the Course | | | | | | Hours | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| II | 21PMA2SP01 | | | Self-Paced Learning: History of Mathematics | | | | | | - | 2 |
| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes(PSO) | | | | | Mean Scores of COs |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 1 | 2 | 3 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 2.2 |
| CO-2 | 2 | 3 | 3 | 1 | 1 | 3 | 1 | 3 | 2 | 3 | 2.2 |
| CO-3 | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 1 | 3 | 2.2 |
| CO-4 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 2.3 |
| CO-5 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 2.1 |
| | | | | | | | | | Mean Overall Score | | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| II | 21PSS2SE01 | SEC: SOFT SKILLS | 4 | 3 |

***Course outcomes (COS)***
***Upon completionof thiscourse, students will:***

- be exposedandtrainedinvariousnuancesofSoftSkillsinaProfessional manner responding to therequirements ofnational and international market
- beabletosynthesizetheknowledgeandpracticalskillslearnttobepersonal effectivein any managerial positions
- be equipped to construct plans and strategies to work for better human society
- beabletoillustratetheproblemsatworkandhomeanddesignsolutionsand maintaina balanceof workand home
- beabletoconnectonacontinuumandmaintaingrowthandsustainabilityand creativity in employment that increases inproductivity,profitforindividuals and the society.

**Module 1: Effective Communication&Professionalcommunication**

Effectivecommunication: Definition of communication, Process of Communication, Barriers of Communication, Non-verbal Communication. JOHARI Window asatoolof effective communication.

Professional Communication:TheArt ofListening,Thepassage, Kinesthetic, Production of Speech, Speech writing,Organization ofSpeech,Modes of delivery, Conversation Techniques, Good manners andEtiquettes, Different kinds ofEtiquettes, Politeness markers.

**Module II. ResumeWriting&InterviewSkills**

**ResumeWriting**: Meaning and Purpose. ResumeFormats. Types ofs Resume. Functional and Mixed Resume**,** Steps in preparation ofResume,Model resumes foranITprofessional Chronological, Types ofinterviews, Creativeresumes using online platforms

**InterviewSkills:**Common interview questions, Dos and Don'ts foran interview, Attitude, Emotions, Measurement,Body Language,Facial expressions,Different types of interviews, Telephonicinterviews, Behavioral interviews andMock interviews(Centralized).

**Module III: GroupDiscussion &TeamBuilding**

**GroupDiscussion:** Group Discussion Basics,GDasthe first criterion for selecting software testers, Essentials of GD,Factors that matter in GD, GD parametersfor evaluation,Points for GDTopics, GDTopicsfor Practice, Tipsfor GDparticipation. Video shooting ofGD presentation & Evaluation(Centralized)

**TeamBuilding**: Characteristics ofateam, Guidelines for effectiveteam membership, Pedagogy of team building, Team building skills.Team VsGroup – synergy, Typesof synergy, Synergy relates to leadership, Stages of TeamFormation,Broken Square-Exercise,Leadership, Leadership styles, Conflict styles, Conflict management strategies & Exercises

**Module IV: PersonalEffectiveness**

Personal Effectiveness:Self Discovery: Personality, Characteristics of personality, kinds of self, Personality inventory table, measuring personality, intelligence andExercises

Self Esteem:Types-High & Low self esteem,Ways of proving self esteem, Hypersensitive to criticism, activities. Goal setting: Goal setting process,Decision making process& Exercises. Stress Management:Identifying stress, Symptomsof stress, Responding to Stress, Sources of stress, Coping with stressand Managing stress.

**Module V:NumericalAbility**

Average, Percentage, Profit and Loss**,** Problems of ages, Simple Interest, Compound Interest,Area,Volume and SurfaceArea,Illustration,Timeand Work, Pipes and Cisterns, Time and Distance**,** Problems on Trains**,** Illustrations, Boatsand Streams, Calendars and Clocks.

**Module VI: Test ofReasoning**

Verbal Reasoning: Numberseries, letter series, coding and decoding, logical sequenceof words, Assertion and Reasoning, Data Sufficiency, Analogy, Kinds of relationships.

**Non-Verbal Reasoning: Completionof** Series**,** Classification, analogical,Pattern comparison, Deduction offigures out of series, Mirror Reflection Pattern, Hidden figures, Rotationpattern, Pattern completion and comparison, Senseof direction, Blood relations.

**Text cumExercise book**

1. MelchiasG,BalaiahJohn,JohnLoveJoy(Eds),2018.WinnersintheMaking:Aprimeronsoft skills. SJC, Trichy.

**References**

* Aggarwal, R.S.*QuantitativeAptitude, S.Chand& Sons*

*.Aggarwal,R.S. (2010). *A Modern Approach toVerbal and Non Verbal Reasoning*. S.Chand
&C0,RevisedEdition.

* Covey, Stephen. (2004). *7 Habits of Highly effectivepeople*,FreePress.

*Egan,Gerard.(1994).*TheSkilledHelper*(5thEd).PacificGrove,Brooks/Cole.

* Khera,Shiv(2003).*You Can Win.* Macmillan Books, Revised Edition.

**OtherText Books**

* Murphy, Raymond. (1998). *Essential English Grammar*. 2nded., CambridgeUniversity Press.

* Prasad, L. M. (*2000). OrganizationalBehaviour, S.Chand& Sons.*

*Sankaran,K., & Kumar, M.*Group Discussion and PublicSpeaking.* M.I. Pub, Agra, 5thed., Adams Media.

* Schuller, Robert. (2010) .*PositiveAttitudes*. Jaico Books.

* Trishna's (2006).*How to do wellin GDs & Interviews*, TrishnaKnowledgeSystems.

** Yate, Martin. (2005).H*iring the Best: A Manager's Guide to EffectiveInterviewing and Recruiting**

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **II** | **21PMA2EG01** | **GE- 1: (WS)<br>MATHEMATICAL FOUNDATIONS** | **4** | **3** |

| CONo. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| **CO-1** | have knowledge of relations, functions, mathematical logic, lattices and numerical methods. | **K1** |
| **CO-2** | understand the types of functions, conditional statements and tautology in mathematical logic, properties of lattices, Boolean algebra, numerical techniques to find the roots and interpolation methods. | **K2** |
| **CO-3** | apply mathematical induction, composition of functions, logical notation to write an argument, suitable method to solve linear equations and numerical integration, interpolation. | **K3** |
| **CO-4** | analyze various types of function, statements using truth tables, use Boolean algebra to design and simplify logic circuits, numerical methods to find solutions of linear equations and system of equations using different methods. | **K4** |
| **CO-5** | justify relations and functions, to construct mathematical arguments using logical connectives and quantifiers, lattices. Evaluate solutions of system of linear equations and numerical integration. | **K5 &K6** |

**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.

***Note:*** *Stress on solving Numerical problems in Units IV and V. No Derivations.*

**Books for Study**

1. Dr. M.K. Venkataraman, Dr. N. Sridharan, N. Chandrasekaran., *Discrete Mathematics*, The National Publishing Company, Chennai. 2006.

**Unit-I** *Chapter II (Sec 2, 5), Chapter III (Sec 1, 2, 3, 4, 5), Chapter IV (Sec 2)(Theorems are excluded).*

**Unit-II** *Chapter IX (Sec 1, 2, 3, 6, 7)*

**Unit-III** *Chapter X (Sec 1, 2, 3,4, 5) (Definition and example onlyfor Sec 5)*

2. M.K. Jain, S.R.K. Iyengar, R.K. Jain., *Numerical Methods for Scientific and Engineering Computation*, 4th Edition, New Age International (P) Limited, Publishers, 2003.

**Unit-IV** *Chapter 2 (Sec 2.9,), Chapter 3 (Sec 3.2, 3.4).*

**Unit-V** *Chapter 4 (Sec 4.2, 4.4), Chapter 5 (Sec 5.9, 5.10).*

**Books for Reference**


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


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| II | 21PMA2EG01 | GE- 1: (WS) MATHEMATICAL FOUNDATIONS | 4 | 3 |

| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | | Mean Scores of COs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2.4 |
| CO-2 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 2.3 |
| CO-3 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | 2.3 |
| CO-4 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 2 | 2 | 2.3 |
| CO-5 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 2.4 |
| | | | | | | | | | | Mean Overall Score | 2.34 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **III** | **21PMA3CC08** | **CORE – 8:<br>MEASURE AND INTEGRATION** | **6** | **6** |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | have knowledge of integration using measures. | **K1** |
| **CO-2** | understand the analysis in abstract situations. | **K2** |
| **CO-3** | identify integral of derivative with differentiation of an integral. | **K3** |
| **CO-4** | analyze the basic results associated to Measurablefunctions, Integration Signedmeasure, decomposition theorems. | **K4** |
| **CO-5** | evaluate the Outer measure and Measurability byapplying Extensiontheorem, product measures, Fubini'stheorem and Tonelli's theorem. | **K5 & K6** |

**Unit-I** **(18 Hours)**

Lebesgue Measure Outer measure - Measurable sets and Lebesgue Measure - Properties - A non-measurable set - Measurable Functions - Little Wood's three principles. (Proofs of Egoroff's theorem and Lusin's theorem to be omitted)

**Unit-II:** **(18 Hours)**

Lebesgue Integral of simple function - bounded measurable function - of a nonnegative function - Fatou's lemma - Monotone Convergence theorem - General Lebesgue integral - Lebesgue convergence theorem – Convergence in measure.

**Unit-III:** **(18 Hours)**

Differentiation of monotone functions - Vitali's lemma - Integral of derivative - Functions of bounded variation - Differentiation of an integral - absolute continuity-Convex functions-Jensen's inequality

**Unit-IV** **(18 Hours)**

Measure spaces - Measurable functions - Integration - Signed measure - Hahn decomposition theorem - Jordan decomposition theorem – Radon-Nikodhym theorem- Lebesgue decomposition theorem

**Unit-V:** **(18 Hours)**

Outer measure and Measurability - Extension theorem – product measures Fubini's theorem – Tonelli's theorem.

**Book for Study**

1. H.L. Royden, "*Real Analysis"*, Third Edition, Prentice Hall of India, New Delhi, 2007.

**Unit-I** *Chapter 3 (Sec. 1 – 6)*
**Unit-II** *Chapter 4 (Sec. 1 – 5)*
**Unit-III** *Chapter 5 (Sec. 1 – 5)*
**Unit-IV** *Chapter 11 (Sec.1- 6)*

**Unit-V** *Chapter 12 (Sec. 1, 2,4)*

**Books for Reference**

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

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|
| **III** | **21PMA3CC08** | | | **CORE – 8: MEASURE AND INTEGRATION** | | | | **6** | | **6** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 3 | 3 | 3 | 2.2 |
| **CO-2** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2.3 |
| **CO-3** | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.3 |
| **CO-4** | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 2.3 |
| **CO-5** | 1 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 1.9 |
| | | | | | | | | | **Mean Overall Score** | | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **III** | **21PMA3CC09** | **CORE – 9: TOPOLOGY** | **6** | **5** |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | acquire knowledge about various types of topological spaces and their properties. | **K1** |
| **CO-2** | understandthe definitions and appropriate examples of fundamental concepts in general topology. | **K2** |
| **CO-3** | apply the properties of open sets, closed sets, interior points, accumulation points and derived sets in deriving the proofs of various theorems. | **K3** |
| **CO-4** | explain the basic concepts of topological spaces such as continuity, compactness, connectedness, regular spaces, normal spaces and the extension theorems. | **K4** |
| **CO-5** | discriminate the topological properties with proper justification. | **K5 & K6** |

**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 UrysohnMetrization Theorem – Tietz Extension theorem.

**Book 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.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | Title of the Course | | | | | | | Hours | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| III | 21PMA3CC09 | CORE – 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 | |
| CO-1 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | 3 | 2.4 |
| CO-2 | 2 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 2 | 2 | 2.3 |
| CO-3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2.3 |
| CO-4 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 1 | 3 | 2.2 |
| CO-5 | 1 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2.3 |
| | | | | | | | | Mean Overall Score | | | 2.3(High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **III** | **21PMA3CC10** | **CORE – 10: ORDINARY DIFFERENTIAL EQUATIONS** | **5** | **5** |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | define linear, non-linear, homogeneous and autonomous system of ordinary differential equations. | **K1** |
| **CO-2** | understand the qualitative properties of solutions by Sturm separation and Sturm comparison theorems. | **K2** |
| **CO-3** | obtain power series solution for ordinary differential equations such as Legendre, Bessel and Gauss hyper geometric equations. | **K3** |
| **CO-4** | obtain and analyze the stability of the solutions for various methods. | **K4, K5** |
| **CO-5** | formulate various physical problems into ordinary differential equations. | **K6** |

**Unit - I** **(15 Hours)**

The general solution of the homogeneous equation – The use of one known solution to find another – The method of variation of parameters – Power Series solutions. A review of power series – Series solutions of first order equations – Second order linear equations; Ordinary points.

**Unit - II** **(15 Hours)**

Regular Singular Points – Gauss's hyper geometric equation – The Point at infinity – Legendre Polynomials – Bessel functions – Properties of Legendre Polynomials and Bessel functions.

**Unit - III** **(15 Hours)**

Linear Systems of First Order Equations – Homogeneous equations with constant coefficients –The Existence and uniqueness of solutions of Initial Value Problems for First Order Ordinary Differential Equations –The method of solutions of successive approximations and Picard's theorem.

**Unit - IV** **(15 Hours)**

Oscillation Theory and Boundary Value Problems – Qualitative properties of solutions – Oscillations and the Sturm separation theorem - Sturm Comparison Theorems.

**Unit-V** **(15 Hours)**

Nonlinear equations: Autonomous Systems; the phase plane and its phenomena –Types of critical points; Stability – Critical points and stability for linear systems –Stability by Liapunov's direct method.

**Books for Study**

1. George F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition 2003.

   **Unit - I** *Chapter3(Sec14, 15, 16, 19)and Chapter5(Sec26, 27, 28)*
   **Unit - II** *Chapter5(Sec 29,30,31,32)and Chapter8 (Sec44, 45, 46, 47)*
   **Unit - III** *Chapter10(Sec 55, 56)and Chapter13(Sec68, 69)*

**Unit - IV** *Chapter 4(Sec24, 25)*
**Unit - V** *Chapter11(Sec58, 59, 60, 61)*

**Books for Reference**

1. W. T. Reid, *Ordinary Differential Equations*, John Wiley & Sons, New York, 1971.
2. Earl A. Coddington, *An Introduction to Ordinary Differential Equations*, Prentice-Hall of India, New Delhi,1992.
3. William E. Boyce, Richard C. Di Prima, *Elementary Differential Equations and Boundary Value Problems*, 10th Edition, John Wiley and Sons, NY, 2012.

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | **Title of the Course** | | | | | | | | **Hours** | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **III** | **21PMA3CC10** | **CORE – 10: ORDINARY DIFFERENTIAL EQUATIONS** | | | | | | | | **5** | **5** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2.2 |
| **CO-2** | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2.1 |
| **CO-3** | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2.1 |
| **CO-4** | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2.3 |
| **CO-5** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2.3 |
| | | | | | | | | | | **Mean Overall Score** | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **III** | **21PMA3ES03A** | **DSE – 3:<br>ALGEBRAIC NUMBER THEORY** | **5** | **4** |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- Levels) |
|---|---|---|
| **CO – 1** | have knowledge of divisibility, prime numbers, congruences, quadratic reciprocity and Diophantine equations. | **K1** |
| **CO – 2** | understand the concept of number theory to perform numerical and symbolic computations. | **K2** |
| **CO – 3** | solve problems and give short proofs associated with prime numbers, divisors, modulo arithmetic, primitive roots and quadratic residues. | **K3** |
| **CO – 4** | analyze the theory of congruences, Power Residues, The Jacobi Symbol, The Mobius Inversion Formula and linear Diophantine equations. | **K4** |
| **CO – 5** | 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 & K6** |

**Unit – I** **(15 Hours)**

Introduction – Divisibility – Primes – The Binomial Theorem – Congruences - Euler's totient - Fermat's, Euler's and Wilson's Theorems – Solutions of congruences – The Chinese Remainder theorem.

**Unit – II** **(15 Hours)**

Prime power Moduli – Primitive roots and Power Residues – Number theory from an Algebraic Viewpoint – Groups, rings and fields.

**Unit – III** **(15 Hours)**

Quadratic Residues – Quadratic Reciprocity – The Jacobi Symbol – Binary Quadratic Forms – Equivalence and Reduction of Binary Quadratic Forms – sum of two squares.

**Unit – IV** **(15 Hours)**

Greatest integer Function – Arithmetic Functions – The Mobius Inversion Formula - Recurrence Functions – Combinatorial number theory

**Unit – V** **(15 Hours)**

Diophantine Equations – The equation $ax+by = c$. Simultaneous Linear Diophantine Equations – Pythagorean Triangles – Assorted examples

**Book for Study**

1. Ivan Niven, Herbert S, Zuckerman and Hugh L, Montgomery, *An Introduction to the Theory of Numbers*,*Fifth Edition*, John Wiley & Sons Inc, 2004

**Unit – I** *Chapter 1 and Chapter 2 (Sec 2.1 - 2.3)*
**Unit – II** *Chapter 2 (Sec 2.6 - 2.11)*
**Unit – III** *Chapter 3(Sec 3.1 - 3.6*)
**Unit – IV** *Chapter 4*
**Unit – V** *Chapter 5 (Sec 5.1 to 5.4)*

**Books for Reference**


1. Gareth A. Jones and J. Mary Jones, *Elementary Number Theory*, Springer Verlag, Indian Reprint, 2005.
2. David M. Burton, *Elementary Number Theory*, 6th edition, McGraw Hill, 2007.
3. George Andrews, *Theory of Numbers*, Saunders, 1971.
4. J. William, *Fundamentals of Number Theory*, Leveque, Addison-Wesley Publishing Company, Philippines, 1977.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| III | 21PMA3ES03A | DSE – 3: ALGEBRAIC NUMBER THEORY | 5 | 4 |

| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | | Mean Scores of COs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2.2 |
| CO-2 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 2.1 |
| CO-3 | 1 | 2 | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 2 | 2.2 |
| CO-4 | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 2.2 |
| CO-5 | 2 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | 2.5 |
| | | | | | | | | | | Mean Overall Score | 2.24 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **III** | **21PMA3ES03B** | **DSE – 3: OPTIMIZATION TECHNIQUES** | **5** | **4** |

| CO No. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | relate the concepts of theory of optimization while solving the problem. | **K1** |
| **CO-2** | understand the theory behind optimization techniques. | **K2** |
| **CO-3** | apply suitable theory in the optimal problem. | **K3** |
| **CO-4** | compare the uses of different theories and methods available. | **K4** |
| **CO-5** | evaluate the optimal solution for the given function. | **K5 & K6** |

**Unit-I** **(15 Hours)**

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

**Unit-II** **(15 Hours)**

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

**Unit-III** **(15 Hours)**

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

**Unit-IV** **(15 Hours)**

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

**Unit-V** **(15 Hours)**

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

**Book for Study**

1. David G. Luenberger, "*Optimization by Vector Space Methods"*,Wiley Professional Paperback series, 1997.
   **Unit – I** *Sec7.1-7.6 (Pages169-184)*
   **Unit – II** *Sec7.8, 7.10-7.13 (Pages 190, 191,195-208)*
   **Unit – III** *Sec 9.1-9.4 (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. C. Nelson Dorny, *A Vector Space Approach to Models and Optimization*, Robert Krieger Publishing Co. 1986.
2. Chander Mohan and Kusum Deep, *Optimization Techniques,* New Age International, 2010
3. Hamley A and Taha, *Operations Research*: *An introduction*, Prentice Hall, New Delhi, Ninth Edition, 2011.

## Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

| Semester | Course Code | | | Title of the Course | | | | Hours | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| III | 21PMA3ES03B | | | DSE – 3: OPTIMIZATION TECHNIQUES | | | | 5 | | 4 |
| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | Mean Scores of COs |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2.1 |
| CO-2 | 2 | 3 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2.2 |
| CO-3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 1 | 2 | 2.3 |
| CO-4 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2.1 |
| CO-5 | 3 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2.3 |
| Mean Overall Score | | | | | | | | | | | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| III | 21PMA3AE01 | AEC: PROBLEM SOLVING IN ADVANCED MATHEMATICS | 4 | 3 |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| CO-1 | acquire knowledge of fundamental concepts on Analysis, Algebra, and Differential Equations and Logical reasoning. | K1 |
| CO-2 | understand the nuances of problem-solving approach in Real Analysis Complex Analysis and Algebra and Quantitative aptitude. | K2 |
| CO-3 | identify and apply the relevant techniques to solve problems in pure mathematics, quantitative aptitude and logical reasoning. | K3 |
| CO-4 | analyze and evaluate the efficiency of a specific technique when solving a problem. | K4&K5 |
| CO-5 | develop new problem-solving methodology to tackle problems in Advanced Mathematics and quantitative aptitude. | K6 |

**Unit-I** **(12 Hours)**

Sets-open-closed-compact-connected-Sequences and series – Sequences and series of functions Continuity, uniform continuity, differentiability, mean value theorems. Analytic functions, Cauchy-Riemann equations., Harmonic functions, Complex integration, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, classification of singularities and calculation of residues.

**Unit-II** **(12 Hours)**

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclicgroups, permutation groups, Cayley'stheorem, class equations, Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, Vector spaces, subspaces, linear dependence, basis, dimension,

**Unit-III** **(12 Hours)**

Linear Transformations, Rank and nullity, Rank and determinant of matrices, systems of linear equations. Eigen values and eigen vectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Linear Differential Equations, Wronskian, singular and regular solutions Existence and uniqueness of solutions of initial value problems for first order ODE's.

**Unit IV** **(12 Hours)**

Problem Solving on Profit and Loss-Ages- Time and Work-Time and Distance-Trains-Area, Volume Surface- Problem Solving on Permutations and Combinations-Probability.

**Unit V** **(12 Hours)**

Logical Reasoning -Deductions-Statements-Assumptions-Conclusions.

**Books for Study**


1. A.P. Singh,*Info Study's Real Analysis*, Info study Publications 2017.
   **Unit I** *Chapter 1(Sec 1.24-1.40), Chapter 2 (Sec 2.1-2.3) and Chapter 3(Sec 3.1-3.4)*
2. A.P. Singh, *Info Study's Complex Analysis*, Info Study Publications 2017.

**Unit- I** *Chapter 2 (Sec 2.5-2.8) Chapter 3 (Sec3.1-3.6) and Chapter 5(5.1-5.5)*

3. A.P.Singh *Info Study's Modern Algebra*, Info study Publications 2017.
**Unit-II** *Chapter 1 (Sec 1.1-1.7,1.9,1.10,1.11) and Chapter 2 (Sec 2.1-2.7)*

4. A.P.Singh *Info Study's Linear Algebra*Info study Publications 2017.
**Unit-II** *Chapter 1 (1.1-1.6) and Chapter 2 (Sec 2.1-2.7)*
**Unit -III** *Chapter 3 (Sec 3.1-3.13, 3.16) and Chapter 4 (Sec 4.1-4.18)*

5. A.P.Singh *Info Study's Differential Equation*Info study Publications 2017.
**Unit -III** *Chapter 2(Sec 2.1-2.10,2.12, 2.13- Omit 2.11) and Chapter 3 (Sec 3.1)*

6. R. S. Agarwal *Quantitative Aptitude* S. Chand & Co. 2017.
**Unit- IV** *Chapters8, 12, 17, 18, 20, 24, 25, 30, 31*

7. R.S Agarwal,*A Modern Approach to Verbal &Non Verbal ReasoningRevised Edition*. S. Chand & Co. 2009.
**Unit -V** *Part I Section II Chapters 1, 3, 5.*

**Books for Reference**


1. Walter Rudin, Principles of Mathematical Analysis, Third Edition, Mc Graw-Hill International Book Company, New York, 1976
2. John B.Conway, Functions of one Complex Variable, Second Edition, Springer Graduate
Texts in Mathematics, New York, 1978
3. Seymour Lipschutz and Marc Lipson, Schaum's Outlines Linear Algebra Third Edition
4. Earl A.Coddington,An Introduction to Ordinary Differential Equations, Prentice-Hall of India, New Delhi,1992


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | Title of the Course | | | | | Hours | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| III | 21PMA3AE01 | AEC: PROBLEM SOLVING IN ADVANCED MATHEMATICS | | | | | 4 | 3 | | | |
| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | | Mean Scores of COs |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 3 | 3 | 3 | 2.2 |
| CO-2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2.3 |
| CO-3 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.3 |
| CO-4 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 2.3 |
| CO-5 | 1 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 1.9 |
| Mean Overall Score | | | | | | | | | | | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| III | 21PMA3EG02 | GE-2: (BS)<br>OPERATIONS RESEARCH | 4 | 3 |

| CONo. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| CO-1 | acquire knowledge of transportation problem, assignment problem, decision-making problem, replacement problem and network scheduling. | K1 |
| CO-2 | compare the basic feasible solution using various methods and predict suitable decision under uncertainty and best critical path. | K2 |
| CO-3 | differentiate balanced and unbalanced problem, feasible and optimum solution and PERT and CPM. | K3 |
| CO-4 | compute optimum solution of transportation problem, assignment problem, decision-making problem, replacement problem and network scheduling. | K4 |
| CO-5 | estimate best network scheduling and evaluate expected time for the completion of project. | K5 &K6 |

**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: Hungarian Assignment 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 deteriorates gradually - 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.

**Book 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.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| Semester | Course Code | Title of the Course | | | | | | | Hours | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| III | 21PMA3EG02 | GE 2 : (BS) OPERATIONS RESEARCH | | | | | | | 4 | 3 |
| Course Outcomes↓ | Programme Outcomes (PO) | | | | | Programme Specific Outcomes (PSO) | | | | | Mean Scores of COs |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | |
| CO-1 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 2.1 |
| CO-2 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 2.1 |
| CO-3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 2.2 |
| CO-4 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 2 | 2.3 |
| CO-5 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | 2.3 |
| | | | | | | | | | Mean Overall Score | | 2.2(High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **IV** | **21PMA4CC11** | **CORE – 11: FUNCTIONAL ANALYSIS** | **6** | **6** |

| CO No. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| **CO-1** | have knowledge of certain topological –algebraic structures such as normed linear spaces, Banach spaces, Hilbert spaces and inner product spaces. | **K1** |
| **CO-2** | understand the main properties of bounded operations between Banach and Hilbert spaces. | **K2** |
| **CO-3** | identify the duals of some normed linear spaces and the orthogonal sets by applying some specific techniques. | **K3** |
| **CO-4** | analyze the basic results associated to different types of convergence in normed linear spaces. | **K4** |
| **CO-5** | evaluate the extension of a given functional with norms, orthogonal complement and examine separability, reflexivity of normed linear spaces. | **K5 &K6** |

**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 $\mathcal{C}[0,1]$- 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- Complete Orthonormal Sets – Riesz Representation Theorem - Dual Spaces.

**Unit-V** **(18 Hours)**

Introduction to Banach Algebra – Adjoin to fan Operator-Isometric Operator - Unitary Operator - Self - Adjoint Operator - Normal Operator - Projection Operator and its Properties.

**Book for Study**

1. S. C. Bose, *Introduction to Functional Analysis*, MacMillan Publishers India, Delhi, 1992.
   **Unit-I** *Chapter 3*
   **Unit-II** *Chapter 4 (Sec: 1 - 7)*
   **Unit-III** *Chapter 5 (Sec: 1, 3) and Chapter 6 (Sec 1, 3)*
   **Unit-IV** *Chapter 7*

**Unit-V** *Chapter 8*

**Books for Reference**

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

**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | | **Hours** | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|
| **IV** | **21PMA4CC11** | | | **CORE–11: FUNCTIONAL ANALYSIS** | | | | | **6** | **6** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 2.5 |
| **CO-2** | 2 | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 3 | 2.3 |
| **CO-3** | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2.2 |
| **CO-4** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2.6 |
| **CO-5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2.4 |
| **Mean Overall Score** | | | | | | | | | | | 2.40 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| IV | 21PMA4CC12 | CORE – 12: PARTIAL DIFFERENTIAL EQUATIONS | 5 | 5 |

| CONo. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| CO-1 | have knowledge to classify partial differential equations and solve linear and non-linear partial differential equations using various methods. | K1 |
| CO-2 | understand different methods of solving partial differential equations. | K2 |
| CO-3 | apply the first, second and higher order partial differential equations in mathematical physics. | K3 |
| CO-4 | formulate partial differential equations and analyze their solutions. | K4 & K5 |
| CO-5 | identify the three main classes of second order partial differential equations- elliptic, parabolic and hyperbolic and evaluating their solutions. | K6 |

**Unit-I** **(15 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** **(15 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** **(15 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** **(15 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** **(15 Hours)**

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

**Book for Study**

1. Ian N. Sneddon, *Elements of Partial Differential Equations*, Dover Publication INC, NewYork, 2006.

| | |
|---|---|
| **Unit-I** | *Chapter II (Sec 1-7)* |
| **Unit-II** | *Chapter II (Sec.8-13)* |
| **Unit-III** | *Chapter III (Sec.1-6)* |
| **Unit-IV** | *Chapter III (Sec.7-11)* |
| **Unit-V** | *Chapter IV (Sec.2-6)* |

**Books for Reference**


1. M.D.Raisinghania, *Ordinary and Partial Differential Equations*, S. Chand & Co.2005.
2. E.T. Copson, *Partial Differential Equations*, Cambridge University Press, 1975.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | **Title of the Course** | | | | | | | | **Hours** | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **IV** | **21PMA4CC12** | **CORE – 12: PARTIAL DIFFERENTIAL EQUATIONS** | | | | | | | | **5** | **5** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2.8 |
| **CO-2** | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2.6 |
| **CO-3** | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2.8 |
| **CO-4** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2.8 |
| **CO-5** | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2.5 |
| **Mean Overall Score** | | | | | | | | | | | 2.7 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| IV | 21PMA4CC13 | CORE – 13: CALCULUS OF VARIATIONS, INTEGRAL EQUATIONS AND TRANSFORMS | 6 | 6 |

| CONo. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| CO-1 | describe the concepts viz, functional, variations, Integral equations and integral transforms. | K1 |
| CO-2 | identify various methods in variations, integral equations and integral transforms. | K2 |
| CO-3 | understand the real-life problem and find solution by applying suitable method. | K3 |
| CO-4 | examine the existence of solution to a problem. | K4 & K5 |
| CO-5 | formulate variational problem relevant to a real-life situation. | K6 |

**Unit-I** **(18 Hours)**

The calculus of Variations- Strong and Weak Variations-The variational notations and the first variations – Functional -Euler's equations – Commutative Character of the operations of variations and integrations – Other forms of Euler's Equation and their solutions Geodesics.

**Unit-II** **(18 Hours)**

Variational problems involving several unknown functions - Functionals dependent on higher order derivatives-Variational problems involving several independent variables-Constrains and Lagrange multipliers- Isoperimetric problems.

**Unit-III** **(18 Hours)**

The general variation of functional-Variational problems with moving boundaries-Hamilton's principle, Sturm – Liouville's problems and variational methods – Rayleigh's principle – Ritz method.

**Unit-IV** **(18 Hours)**

Integrals Equations - Introduction – Relation between differential and integral equations – Relationship between Linear differential equations and Volterra integral equations – The Green's function and its use in reducing boundary value problems to integral equations – Fredholm equations with separable kernels- Fredholm equations with symmetric kernals: Hilbert Schmidt theory– Iterative methods for the solution of integrals equations of the second kind– The Neumann series –orthogonal kernels.

**Unit-V** **(18 Hours)**

Fourier transform – The infinite Fourier transform – The finite Fourier transform – Fourier integral theorem – Different forms of Fourier integrals formula – Problems related to Fourier integral and finite transform.

**Books for Study**

1. Dr. M.K.Venkatarman, *Higher Mathematics for Engineering and Sciences*, The National Publishing Company, 2001.

**Unit-I** *Chapter 9(Sec 1-10*)

**Unit-II** *Chapter 9(Sec 11-15)*

**Unit-III** *Chapter 9 (Sec 16-21)*
**Unit- IV** *Chapter 10 (Sec 1-11*)

2. J.K. Goyal and K.P. Gupta, *Integral Transforms*, K.K. Mittal for Pragati Prakashan, 20th Edition (2019).

**Unit-V** *Chapter 2 (Part 1 and Part 2)*

**Books for Reference**


1. Krasnov, Kiselu and Marenko, *Problems and Exercise in Integrals Equations*, MIR Publishers 1971.
2. Francis. B. Hildebrand, *Methods of Applied Mathematics*, Prentice - Hall of India Pvt. Ltd., New Delhi, Second Edition 1968.
3. Ram. P. Kanwal, *Linear Integral Equations* – Theory and Techniques, Academic press, New York, 1971.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | **Title of the Course** | **Hours** | **Credits** |
|---|---|---|---|---|
| **IV** | **21PMA4CC13** | **CORE – 13: CALCULUS OF VARIATIONS, INTEGRAL EQUATIONS AND TRANSFORMS** | **6** | **6** |

| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 3 | 2 | 2 | 3 | 1 | 3 | 3 | 2 | 2 | 3 | 2.4 |
| **CO-2** | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2.3 |
| **CO-3** | 2 | 1 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 3 | 2.3 |
| **CO-4** | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 2 | 2.4 |
| **CO-5** | 1 | 2 | 3 | 2 | 3 | 1 | 3 | 2 | 2 | 3 | 2.2 |
| **Mean Overall Score** | | | | | | | | | | | 2.32 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| IV | 21PMA4ES04A | DSE – 4: AUTOMATA THEORY | 5 | 4 |

| CO No. | CO- Statements<br>On successful completion of this course, students will be able to | Cognitive Levels (K- levels) |
|---|---|---|
| CO-1 | enhance their knowledge in mathematical notions of computation, such as computability, decidability and reducibility of the theory of formal languages and automata. | K1 |
| CO-2 | perceive the techniques of computations including finite state automata, grammars and regular expressions and their relations. | K2 |
| CO-3 | design and explain finite automata without ε-moves, derivation trees, pushdown automata and the lexical analyzer to the compilers. | K3 |
| CO-4 | analyze and recognize the patterns of automata and grammars using regular expressions. | K4 |
| CO-5 | state and explain Chomsky Normal Form and Parsing techniques and implement the stack applications and evaluate them in arithmetic manner. | K5& K6 |

**Unit-I** **(15 Hours)**

Finite Automata and Regular expressions – Definitions and examples – Deterministic and Non deterministic finite Automata – Finite Automata with $\varepsilon$-moves.

**Unit-II** **(15 Hours)**

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

**Unit-III** **(15 Hours)**

Pushdown Automata – Definition and examples – Relation with Context free languages.

**Unit-IV** **(15 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** **(15 Hours)**

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

**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** *Chapter2 (Sec 2.1 - 2.4)*

**Unit – II** *Chapter2 (Sec 2.5) and Chapter 4 (Sec 4.1 - 4.3, 4.5)*

**Unit - III** *Chapter 5 (Sec 5.2, 5.3)*

2. A.V.Aho and Jeffrey D.Ullman, *Principles of Compiler Design*,Narosa Publishing House, Chennai, 2002.

**Unit – IV** *Chapter 3 (Sec 3.1 - 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. A.V.Aho, Monica S.Lam, R.Sethi, J.D.Ullman, *Compilers: Principles, Techniques, and Tools*,Second Edition, Addison-Wesley,2007.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | **Hours** | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|
| **IV** | **21PMA4ES04A** | | | **DSE – 4: AUTOMATA THEORY** | | | | **5** | | **4** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2.3 |
| **CO-2** | 1 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2.3 |
| **CO-3** | 1 | 2 | 2 | 3 | 1 | 2 | 3 | 2 | 2 | 3 | 2.1 |
| **CO-4** | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2.2 |
| **CO-5** | 1 | 2 | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 3 | 2.1 |
| **Mean Overall Score** | | | | | | | | | | | 2.2 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| **IV** | **21PMA4ES04B** | **DSE – 4: C++ PROGRAMMING** | **5** | **4** |

| CONo. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| **CO-1** | recognize the concepts of object-oriented programming | **K1** |
| **CO-2** | summarize various types of operations, functions, constructors, overloading and inheritance | **K2** |
| **CO-3** | practice codes in C++ for solving problems | **K3** |
| **CO-4** | analysis the complexity of C++ programs using different techniques | **K4** |
| **CO-5** | apply the knowledge of C++ to design programs for solving problems | **K5 &K6** |

**Unit-I** **(15 Hours)**

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

**Unit-II** **(15 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** **(15 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** **(15 Hours)**

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

**Unit-V** **(15 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.

**Book for Study**

1. E. Balagurusamy,*Object Oriented Programming with C++*, TATA MCGRAW HILL. Sixth edition 2014.

**Unit- I** *Chapter 2 (Sec 2.1 -2.6) and Chapter 3 (Sec 3.1 -3.13)*
**Unit- II** *Chapter 3 (Sec 3.14 -3.25) and Chapter 4 (Sec 4.1 - 4.10)*
**Unit -III** *Chapter 5 (Sec 5.1 – 5.10) and Chapter 6(Sec 6.1 – 6.5)*
**Unit- IV** *Chapter 6(Sec6.6 – 6.8, 6.11) and Chapter 7 (Sec 7.1 – 7.4)*
**Unit -V** *Chapter 7 (Sec 7.5 – 7.8) andChapter 8 (Sec 8.1 – 8.8)*

**Books for Reference**


1. M.A.Jayaram and D.S. Rajendra Prasad,*Object Oriented Programming With C++*, Mumbai, Himalaya Publishing, 2002.
2. D.Ravichandran,*Programming With C++*,New York, McGraw Hill,1999.
3. Maria Litvin and Gary Litvin,*Programming In C++*,New Delhi,Vikas Publishing House Pvt. Ltd., 2001.


**Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes**

| **Semester** | **Course Code** | | | **Title of the Course** | | | | | **Hours** | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **IV** | **21PMA4ES04B** | | | **DSE – 4: C++ PROGRAMMING** | | | | | **5** | | **4** |
| **Course Outcomes↓** | **Programme Outcomes (PO)** | | | | | **Programme Specific Outcomes (PSO)** | | | | | **Mean Scores of COs** |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | |
| **CO-1** | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2.2 |
| **CO-2** | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 2.1 |
| **CO-3** | 1 | 2 | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 2 | 2.2 |
| **CO-4** | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 2.2 |
| **CO-5** | 2 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | 2.5 |
| **Mean Overall Score** | | | | | | | | | | | 2.24 (High) |

| Semester | Course Code | Title of the Course | Hours | Credits |
|---|---|---|---|---|
| IV | 21PMA4CE01 | COMPREHENSIVE EXAMINATION | - | 2 |

| CO No. | CO- Statements | Cognitive Levels (K- levels) |
|---|---|---|
| | On successful completion of this course, students will be able to | |
| CO-1 | acquire the knowledge on basic concepts, definitions and ideas with examples in Algebra, Analysis, and Topology | K1 |
| CO-2 | understand basic mathematical concepts and computational skills | K2 |
| CO-3 | articulate mathematical concepts and use it in solving problems in Algebra, Analysis, and Topology | K3 |
| CO-4 | Compare the concepts of various subjects in Mathematics | K4 |
| CO-5 | Develop creativity in communicating and solving mathematical problems | K5 & K6 |

**Unit I: Algebra**

Groups – A Counting Principle-Homomorphism- Another Counting Principle -Sylow's theorem - Idealsand 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

**Books for Study**


1. I. N. Herstein, "*Topics in Algebra*", Wiley Eastern Limited, NewDelhi,1992.
2. Walter Rudin, "*Principles of Mathematical Analysis*", Third Edition, McGraw-Hill International Book Company, New York, 1976.
3. Lars V. Ahlfors, "*Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable*", Third Edition, Mac Millan Publishers India,

Delhi, 2013.
4. James R. Munkres, "*Topology*", Second Edition, PHI Learning Pvt Ltd., New Delhi, 2009.
5. SS. C. Bose, Introduction to Functional Analysis, MacMillan Publishers India, Delhi, 1992.

**Books for Reference**

1. Serge Lang, "*Algebra*", Third Edition, Springer Graduate Texts in Mathematics, New York, 2002.
2. Tom M.Apostol, "*Mathematical Analysis*", Addison-Wesley Publishing Company London, 1974.
3. S. Ponnusamy, "*Foundations of Complex Analysis",* Second Edition, Narosa Publishing
   House, India, 2005.
4. James Dugundji, "*Topology*", Allyn & Bacon, 1966.
5. G. F. Simmons, *Introduction to Topology and Modern Analysis*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2006