SRI SANKARA ARTS AND SCIENCE COLLEGE
(AUTONOMOUS)
ENATHUR, KANCHIPURAM - 631561

M.Sc., MATHEMATICS

REGULATION & SYLLABUS

(Effective from the academic year 2023 – 2024)

Choice Based Credit System

Learning Outcomes based Curriculum Framework
(LOCF)
Sri Sankara Arts and Science College
(Autonomous)
Department of Mathematics

Contents

Preamble

We are happy to submit the report concerning the syllabi for M.Sc. Mathematics. The committee discussed the framework of syllabi in its meetings and suggests the implementation of these syllabi in the Department of Mathematics in Sri Sankara Arts and Science College (Autonomous), Enathur, Kanchipuram based on following facts:

1. The learning outcomes of each paper are framed so that these may help learners to understand the main objectives of studying the course.
2. The objectives of LOCF are to mentally prepare the students to learn Mathematics leading to M. Sc Mathematics as a subject.
3. These syllabi in M. Sc Mathematics under CBCS are recommended keeping in view of the wide applications of Mathematics in science, engineering, business and a tool of research areas.
4. The study of the syllabi will enable the students to be equipped with the state of the art of the subject and will empower them to get jobs in technological and engineering fields as well as in business, education and healthcare sectors.
5. The LOCF committee in Mathematics has prepared this draft paying suitable attention to objectives and learning outcomes of the papers. These syllabi may be implemented with minor modifications with appropriate justifications keeping in view regional, national and international context and needs. The outcomes of each paper may be modified as per the local requirements.
6. The papers are organized considering the credit load in a particular semester. The core papers of general interest are suggested for semesters I to IV. The elective courses proposed for the M. Sc Mathematics students in all the semesters.
7. The mathematics is a vast subject with immense diversity. Hence it is very difficult for every student to learn each area of mathematics, even though each paper has its unique importance.

Introduction

The important reforms in the M.Sc. Mathematics level is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive with well-defined aims goals to achieve. The learning in outcomes is attained by students through skills acquired during a programme of study. Programme learning outcomes will include subject-specific skills and to enhance the research skills. It would also focus on knowledge and skills that prepare students for further study, employment. The quality of higher education in mathematics should be improved in such a manner that young minds are able to acquire the knowledge and proficiency in various fields. The goal of higher education in mathematics may be achieved using the following measures:

i. Curriculum reform based on a learning outcomes-based curriculum framework (LOCF).

ii. Developing learning environment and academic resources.

iii. Elevating the quality of teaching and research.

iv. Involving students in discussions, problem-solving and out of box thinking about various ideas of mathematics and their applicability, which may lead to empowerment and enhancement of the social welfare at large.

vi. Motivating the learner's development to understand wide concepts of mathematics keeping in view the regional context.

vii. Provoking learners to create research atmosphere in mathematical sciences in their colleges/institutes/universities.

viii. Teach courses of mathematics based on Choice Based Credit System (CBCS). One of the benchmarks to measure the progress of a country is the advancement of the knowledge of mathematics. Hence, sophisticated measures should be taken to improve the quality of mathematical knowledge in our society. This is also because mathematics has wide ranging applications in engineering, technology and a host of other areas

LOCF

Learning Outcomes-based approach to Curriculum Planning

In the end of M.Sc. Mathematics, students will be awarded on the basis of learners acquired knowledge, understanding, skills, attitudes, values and academic achievement. Hence, the learning outcomes of mathematics for these courses are aimed at facilitating the learners to acquire these attributes, keeping in view of their preferences and aspirations for framed knowledge of mathematics. The LOCF in mathematics has framed courses in the graduate attributes, description of qualifications, courses and programme learning outcomes. The syllabi of mathematics were framed by the committee in such a way that it may lead to all round development and delivery fulfilled curriculum. Guidelines provided in the aspects of, acquiring sufficient knowledge during this programme by the learner. The aims of Learning Outcomes-based approach to Curriculum (Mathematics) are to prepare the syllabi having standard level of study. The main aim of the LOCF is to follow the criteria for teaching-learning process and examination pattern. Therefore, the programme has been written out in such manner that there is scope of elasticity and novelty in

I. Changes of recommended syllabi.

II. Methodology of Teaching.

III. Knowledge levels and Valuation Process of students.

IV. LO (Learning outcomes) of courses.

V. Elective courses introduced by availability of experts in colleges/institutes/universities across the country.

Graduate Attributes in Mathematics

The overall expected course learning outcomes prescribed in the commencement of each course are called the graduate attributes in mathematics. Some of are,

Disciplinary knowledge:

Learning one or more disciplines which form a component of postgraduate programme of study.

Communications skills:

Ability to communicate in understanding, interpreting, expressing, responding and using the mathematical symbols to put up the ideas in both oral and written form.

Critical thinking and analytical reasoning:

Ability to depict critical thinking in understanding the concepts in every area of mathematics. Ability to interpret the results and apply them in various problems appearing in different areas of mathematics

Problem solving:

Solving problems using computer graphics in various models such as growth and decay models, radioactive decay model, drug assimilation, LCR circuits and population models using techniques of differential equations.

Research-related skills:

To study a particular problem using scientific methods with observed phenomena for required interpretation using mathematics.

Information/digital literacy:

To solve problems related to mathematical concepts using appropriate software like MATLAB, Python, LaTeX, SPSS, MINITAB and other advanced software.

Self-directed learning:

Capability to work independently and do in-depth study of various areas of mathematics.

Qualification-descriptors.

The qualification descriptors with the specifications of academic standards providing the ethnic outcomes and features includes the following factors

I. Level of Knowledge
II. Understanding
III. Skills
IV. Competencies and Attitudes
V. Values

The above parameters are experienced by the learners after graduation and are considered at the time of designing, approving, assessing and reviewing academic programme by all the institutions/Colleges. All the graduates will be benefitted with equal opportunity irrespective of class, gender, community and religion by learning experiences and assessment procedures.

Each learner in the M.Sc. Mathematics should be able to

1. Knowledge in the subject enhance in specific manner to explore and getting jobs in engineering, science, technology and mathematical sciences with demonstration.
2. Exploring the skills in the areas of extensions of various concepts like analysis, geometry, algebra, mechanics, differential equations etc.
3. Capable to evaluate the problems with identifications, collections and analysis of problems with appropriate methodologies.
4. To extend the subject knowledge in research works in various areas of mathematical sciences by satisfying learning necessities.
5. To explore theme skills in newer field and unexplored areas with its applications

Programme Outcomes:

PO1: Understand the nature of abstract mathematics and explore the concepts in further details.

PO2: Model the real-world problems in to mathematical equations and draw the inferences by finding appropriate solutions.

PO3: Identify challenging problems in mathematics and find appropriate solutions.

PO4: Pursue research in challenging areas of pure/applied mathematics.

PO5: Employ confidently the knowledge of mathematical software and tools for treating the complex mathematical problems and scientific investigations.

Programme Specific Outcomes:

PSO-1: To getting critical and analytic thinking in theoretical aspect

PSO-2: To solving the problem skills in practical aspect

PSO-3: To improve the knowledge, team work presentation skill among the students to do their higher studies in mathematics

PSO-4: To understand the concept of Mathematics and it help to clear the NET/SET/GATE Exams

PSO-5: To getting new ideas basic learning and applying in order to employability

MASTER DEGREE COURSES
CHOICE BASED CREDIT SYSTEM (CBCS)
(Effective from the academic year 2023 – 2024)

REGULATIONS

1. THE CBCS SYSTEM

All Programmes (named after the core subject) mentioned earlier shall be run on **Choice Based Credit System (CBCS).** It is an instructional package developed to suit the needs of students to keep pace with the developments in higher education and the quality assurance expected of it in the light of liberalization and globalization in higher education.

2. ELIGIBILITY FOR ADMISSION

Candidates for admission to the first year of the Master Degree shall be required to have passed the under graduate degree by any one of the University accepted by the Academic Council of the Autonomous College.

M.Sc. MATHEMATICS

A candidate who has passed the B.Sc., degree examination in Branch I Mathematics or B.Sc., Applied Sciences of any University accepted by Academic Council of the Autonomous College as equivalent thereto.

3. ELIGIBILITY FOR THE AWARD OF DEGREE

A Candidate shall be eligible for the award of the Degree only if he / she has undergone the prescribed course of study in a Autonomous College for a period of not less than two academic years, passed the examinations of all the Four Semesters prescribed earning **91** credits in Parts-I, II, III, IV & V and fulfilled such conditions as have been prescribed therefore. The parent univ1ersity will award degrees to the students evaluated and recommended by autonomous colleges. The degree certificates will be in a common format
devised by the university. The name of the college will be mentioned in the degree certificate, if so desired. The declaration of results was decided by the examination committee.

4. DURATION

Each academic year shall be divided into two semesters. The first academic year shall comprise the first and second semesters, the second academic year the third and fourth semesters respectively.

The odd semesters shall consist of the period from June to November of each year and the even semesters from December to April of each year. There shall be not less than 90 working days for each semester exclusive of the days for the conduct of semester examinations.

In each semester, Courses are administered in 15 teaching weeks and another 5 weeks are utilized for evaluation and grading purposes. Each week has 30 working hours spread over in a 5-day week. Depending upon the content and specialization, a paper may have 1 to 6 credits. Total number of teaching hours in a semester will be 450 hrs.

5. MAXIMUM PERIOD FOR COMPLETION OF THE PROGRAMMES

The candidates shall complete the Master's Degree Programmes within 4 years from the date of admission. The term completing the Programmes means passing all the prescribed examinations of the Programme to become eligible for the degree. No candidate shall be permitted to appear for the examinations after the prescribed period for completing the Programme.

6. MEDIUM OF INSTRUCTION

The medium of instruction shall be English.

7. COURSE OF STUDY

A Master's Programme consists of a number of courses (papers). The term Course is used to indicate logical part of a subject matter of the Programme. In each of Master's Programmes, there will be a prescription of (i) Part –I (Core subjects – Theory, Practical's, Project, and Field work), (ii) Part – II (Elective subjects – Inter disciplinary or Extra disciplinary subjects), (iii) Part – III: a set of papers recommended by UGC and TANSCHE (Soft skills), (iv) Part – IV: Internship

The detail of the Study for Master Degree Courses shall consist of the following:

PART – I Core Subjects – Theory, Practical's, Project / Field work

PG students shall be required to take up Project / Field Work and submit the Project Report during the second year. The Head of the Department shall allot the Guide who in turn will suggest the Project Work to the students. Two typed copies of the Project Report shall be submitted to the Department before the due date and one copy will be forwarded to the Controller of Examinations. For the Project Report, the maximum internal marks will be 20 percent, the maximum external marks will be 60 per cent and for the Viva-Voce 20 per cent

(If in some Programmes, if the project is equivalent to more than one paper, the project marks would be in proportion to the number of equivalent papers). Each student shall be required to appear for Viva-Voce Examination in depends of the Project only.

PART – II Elective Subjects – Inter-disciplinary or Extra-disciplinary or self-study elective or open elective

PART – III Skill Based Subjects - Soft Skills

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed papers on Soft Skills. For three years PG degree Programme, a candidate must undergo a minimum of 2 papers (2 x 2 = 4 credits). Papers will be finalized in due course.

PART – IV Internship

Each PG student shall appear for internship training during the vacation of II Semester for a minimum period of 15 days and shall submit the report to the controller of examinations. Each student is allotted 4 credits on submission of the report.

Course: Every course offered will have three components associated with the teaching-learning process of the paper, namely (i) Lecture - L (ii) Tutorial – T (iii) Practical – P, (iv) Self-study - S where

L stands Lecture session. **T** stands Tutorial session consisting participatory discussion / self-study / desk work / brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands Practice session and it consists of Hands-on experience / Laboratory Experiments / Field Studies / Case studies that equip students to acquire the much-required skill component.

S stands Self-study session consisting participatory discussion by student with the guidance of faculty. This session is not included in the weekly hour plan.

In terms of credits, every one-hour session of L amounts to 1 credit per semester, a minimum of two-hour session of T or P amounts to 1 credit per semester and no credits allotted to self-study hour, over a period of one semester of 15 weeks for teaching-learning process. The total duration of a semester is 20 weeks inclusive of semester-end examination.

A paper shall have either or all the three components. That means a paper may have only lecture component, or only practical component or combination of any two or all the three components. The total credits earned by a student at the end of the semester upon successfully completing the paper are L + T + P + S. The credit pattern of the paper is indicated as L: T: P: S.

For example: a theory paper with a L-T-P-S schedule of 4-0-0-2 will be assigned 4 credits, and a lab practical paper with a L-T-P-S schedule of 0-0-3-0 will be assigned 3 credits.

The concerned Board of Studies will choose the convenient credit pattern for every paper based on the requirement. However, generally, a paper shall be of 2 - 6 credits.

Different courses of study are labeled and defined as follows:

Core Course
A course which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main discipline / subject of study or from a sister/related discipline / subject which supports the main discipline / subject. In contrast to the phrase Soft Core, a compulsory core course is called a **Hard-Core** Course**.**

Elective Course
Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline / subject of study or which provides an extended scope or which enables an exposure to some other discipline / subject / domain or nurtures the candidate's proficiency/ skill is called an Elective Course. Elective courses may be offered by the main discipline / subject of study or by sister / related discipline / subject of study. A Soft-Core course may also be considered as an elective.

An elective course chosen generally from an unrelated discipline / subject, with an intention to seek exposure is called an **open elective**. An elective course designed to acquire a special / advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher is called a Self-Study Elective.

A core course offered in a discipline / subject may be treated as an elective by another discipline / subject and vice versa.

Project work / Dissertation work is a special course involving application of knowledge in solving / analyzing / exploring a real-life situation / difficult problem. A project work up to 4 - 6 credits is called Minor Project work. A project work of 8 - 12 credits is called Major Project

Work. Dissertation work can be of 8 - 12 credits. A Project / Dissertation work may be a hard core or a soft core as decided by the Board of Studies concerned.

Student Advisor

All teachers of the department shall function as student advisors. There will be more or less an equal number of students assigned to each student advisor of a department. The student advisor will help the students in choosing core and elective courses of study. The student advisor shall be responsible for registration of courses (subjects) by his students. The student advisor will offer all possible student support services.

8. CREDITS

The term credit is used to describe the quantum of syllabus for various Programmes in terms of periods of study. It indicates differential weightage given according to the content's duration of the courses in the curriculum design. The minimum credit requirement for a two-year Master's programme shall be **91** credits. Each subject (course) is designed variously under lectures / tutorials / laboratory work / seminar / project work etc., to meet effective teaching and learning needs and credits are assigned suitably.

One credit for each lecture / tutorial / project work period per week shall be allotted. In practical, each credit should cover minimum of six experiments. One credit is allotted for two practical hours. Thus normally, in each of the subject, credits will be assigned on the basis of the lectures / tutorials / laboratory work / project work and other forms of learning in a 15-week schedule.

M.Sc. Mathematics Credits

S. No	Study Components	M.Sc.		
		Number of Papers	Credits Per Paper	Total Credits
1	Core Major Papers	9	5	45
2	Core Co-Major Papers	3	4	12
3	Core project viva voce	1	7	7
4	Elective Papers	6	3	18
5	Extension Activity	1	1	1
6	Internship	1	2	2
7	Skill Enhancement	3	2	6
			Total	**91**

SRI SANKARA ARTS AND SCIENCE COLLEGE
AUTONOMOUS
CHOICE BASED CREDIT SYSTEM (CBCS)
(Effective from the academic year 2023 – 2024)

M.Sc. Mathematics

Semester I

Course Components/ Title of the Paper	**Credits**	**Ins Hours**	**CIA**	**EXT**	**Total**
Core Paper I Algebraic Structures	5	7	25	75	100
Core Paper II Real Analysis-I	5	7	25	75	100
Core Paper III Ordinary Differential Equations	4	6	25	75	100
Elective I (Generic / Discipline Specific) (One from Group A)	3	5	25	75	100
Elective II (Generic / Discipline Specific) (One from Group B)	3	5	25	75	100
Skill Enhancement Course-II (One from Group G) Mathematical Documentation using latex-Lab	2	4	20	80	100
	22	30			

Group-A

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

Group-B

1. Lie Groups and Lie Algebras
2. Fuzzy Sets and their Applications
3. **Operations Research**
4. Mathematical Programming

Group-G

1. **Mathematical Documentation using latex-Lab**
2. Computational Mathematics using Sage Math-Lab
3. Numerical Analysis using SCILAB-Lab
4. Differential Equation using SCILAB-Lab

Semester II

Course Components/ Title of the Paper	**Credits**	**Ins Hours**	**CIA**	**EXT**	**Total**
Core Paper IV Advanced Algebra	5	6	25	75	100
Core Paper V Real Analysis II	5	6	25	75	100
Core Paper VI Partial Differential Equations	4	6	25	75	100
Elective III (Generic / Discipline Specific) (One from Group C)	3	4	25	75	100
Elective-IV (Computer / IT related) (One from Group D)	3	4	25	75	100
Skill Enhancement Course-II (One from Group G) Computational Mathematics using Sage Math-Lab	2	4	20	80	100
	22	30			

Group-C

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

Group-D

1. Modelling and Simulation with Excel
2. **Java**
3. Machine learning and Artificial Intelligence
4. Neural Networks

Group-G

1. Mathematical Documentation using latex-Lab
2. **Computational Mathematics using Sage Math-Lab**
3. Numerical Analysis using SCILAB-Lab
4. Differential Equation using SCILAB-Lab

Semester III

Course Components/ Title of the Paper	**Credits**	**Ins Hours**	**CIA**	**EXT**	**Total**
Core Paper VII Complex Analysis	5	6	25	75	100
Core Paper VIII Probability Theory	5	6	25	75	100
Core Paper IX Topology	5	6	25	75	100
Core Paper X Statistical Methods	4	6	25	75	100
Elective V (Generic / Discipline Specific) (One from Group E)	3	3	25	75	100
Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	2	-	20	80	100
Skill Enhancement Course-III (One from Group G) Numerical Analysis using SCILAB-Lab	2	3	20	80	100
	26	30			

Group-E

1. Algebraic Number Theory
2. **Fluid Dynamics**
3. Stochastic Process
4. Mathematical Python -I

Group-G

1. Mathematical Documentation using latex-Lab
2. Computational Mathematics using Sage Math-Lab
3. **Numerical Analysis using SCILAB-Lab**
4. Differential Equation using SCILAB-Lab

IV Semester

Course Components/ Title of the Paper	**Credits**	**Ins Hours**	**CIA**	**EXT**	**Total**
Core Paper XI Functional Analysis	5	5	25	75	100
Core Paper XII Differential Geometry	5	5	25	75	100
Elective VI (Generic / Discipline Specific) (One from Group F)	3	5	25	75	100
Core Project with viva voce	5	4	20	80	100
Skill Enhancement Course-IV (One from Group G) Differential Equation using SCILAB-Lab	2	4	20	80	100
Extension Activity	1	Performance based Assessment			
	21	30			

Group-F

1. Algebraic Geometry
2. Financial Mathematics
3. **Discrete Mathematics**
4. Mathematical Python - II

Group-G

1. Mathematical Documentation using latex-Lab
2. Computational Mathematics using Sage Math-Lab
3. Numerical Analysis using SCILAB-Lab
4. **Differential Equation using SCILAB-Lab**

<table>
<tr><td>Title of the Course</td><td colspan="6">Algebraic Structures</td></tr>
<tr><td>Paper Number</td><td colspan="6">I</td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>I
I</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="6">UG level Modern Algebra</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To study and develop the concepts of group theory.
➢ To learn the importance of Sylow’s theorems and its applications.
➢ To understand various canonical forms of transformations.
➢ To learn the base knowledge of Research.
➢ To learn the base knowledge of CSIR/SET/PGTRB.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="3">UNIT I : Another Counting Principle-Sylow’s Theorem.
RTB (1): Chapter 2: Sections 2.11 and 2.12</td><td>16</td><td>CO-1</td><td>K1
K3</td></tr>
<tr><td colspan="3">UNIT II : Direct Products - Finite Abelian Groups- Modules
RTB (1): Chapter 2: Sections 2.13 and 2.14
RTB (1): Chapter 4: Section 4.5</td><td>14</td><td>CO-2</td><td>K1
K5
K3</td></tr>
<tr><td colspan="3">UNIT III : Canonical Forms: Triangular Form – Canonical Forms: Nilpotent Transformations.
RTB (1): Chapter 6: Sections 6.4, 6.5</td><td>15</td><td>CO-3</td><td>K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT IV : Canonical Forms-Jordan Form – Canonical Forms: Rational Canonical form.
RTB (1): Chapter 6: Sections 6.6 and 6.7</td><td>15</td><td>CO-3
CO-4</td><td>K1
K2
K5</td></tr>
<tr><td colspan="3">UNIT V : Trace and Transpose - Hermitian, Unitary- Normal transformations- Real Quadratic form.
RTB (1): Chapter 6: Sections 6.8, 6.10 and 6.11 (Omit 6.9)</td><td>15</td><td>CO-5</td><td>K1
K3</td></tr>
<tr><td></td><td colspan="3">Total</td><td>75</td><td></td><td></td></tr>
</table>

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Topics in Algebra (II Edition)	I.N. Herstein	Wiley Publications	2016
Reference Books (RB)	1	Algebra	Michael Artin	Prentice Hall	1991
	2	Algebra I & II	I.S. Luther and I.B.S. Passi	Narosha Publishing House, New Delhi	1999
	3	Abstract Algebra Third Edition	David S. Dummit and Richard M. Foote	Wiley Publications	2014
	4	Contemporary Abstract Algebra Fourth Edition	Joseph A. Gallian	Narosa Publishing House Pvt. Ltd.	1999
	5	Basic Abstract Algebra (II Edition)	P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul	Cambridge University Press	1997
	6	Basic Algebra I & II	N. Jacobson and W.H. Freeman	Hindustan Publishing Company, New Delhi	1980
	7	Fundamental of Abstract Algebra	D.S. Malik, J. N. Mordeson and M.K. Sen	McGraw Hill (International Edition), New York	1997

<table>
<tr><td>Title of the Course</td><td colspan="6">Real Analysis I</td></tr>
<tr><td>Paper Number</td><td colspan="6">II</td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>I
I</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="6">Basic Knowledge about Real number system and Calculus.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To give a thorough knowledge of the various aspects of Riemann-Stieltjes Integral.
➢ To learn the base knowledge of CSIR/SET/PG-TRB.
➢ To learn the base knowledge of Research.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="3">UNIT-I: Functions of bounded variation - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation. Infinite Series: Absolute and conditional convergence - Dirichlet’s test and Abel’s test - Rearrangement of series - Riemann’s theorem on conditionally convergent series.
RTB(1): Chapter – 6: Sections 6.1 to 6.8
RTB(1): Chapter 8: Sections 8.8, 8.15, 8.17, 8.18</td><td>15</td><td>CO-1</td><td>K1
K3</td></tr>
<tr><td colspan="3">UNIT-II: The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.</td><td>14</td><td>CO-1
CO-2</td><td>K1
K3</td></tr>
</table>

	RTB(1): Chapter - 7: Sections 7.1 to 7.14			
	UNIT-III: The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter-Differentiation under integral sign-Lebesgue criterion for existence of Riemann integrals. **RTB(1): Chapter- 7 : 7.15 to 7.26**	16	CO-3	K1 K3
	UNIT-IV: Infinite Series and infinite Products - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesarosummability - Infinite products. Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem **RTB(1): Chapter – 8: Sec, 8.20 to 8.26** **RTB(1): Chapter - 9: Sections 9.14,9.15, 9.19, 9.20, 9.22, 9.23**	15	CO-3 CO-4	K1 K3
	UNIT-V: Sequences of Functions – Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions -Uniform Convergence and Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.	15	CO-5	K1 K3

	RTB(1): Chapter -9: Sec 9.1 to 9.6, 9.8, 9.9, 9.10, 9.11, 9.13			
	Total	75		

	S. No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Mathematical Analysis, 2nd Edition,	Tom M. Apostol	Addison-Wesley Publishing Company Inc. New York,	1974
Reference Books (RB)	1	Principles of Real Analysis	S. C. Malik	New Age International (Pvt.) Ltd., Publisher (3rd Edition)	2011
	2	Real Analysis	Bartle R. G	John Wiley and Sons Inc.	1976
	3	Real Analysis	M. L. Khanna L. S. Varshney	Jai Prakash Nath and Co namaste (6th Edition)	2011
	4	Real Analysis	H. L Royden	Prentice Hall of India, New Delhi	2007
	5	Mathematical Analysis	Tom M Apostol	Narosa Publishing House Pvt. Ltd (2nd Edition)	2002
	6	Introduction to Real Analysis	Sanjay Arora and Bansi Lal	Satya Prakashan, New Delhi	1991
	7	Principles of Real Analysis	A.L. Gupta and N.R. Gupta	Pearson Education, (Indian print)	2003

<table>
<tr><td>Title of the Course</td><td colspan="7">Ordinary Differential Equations</td></tr>
<tr><td>Paper Number</td><td colspan="7">III</td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>I
I</td><td>Credits</td><td>4</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="7">UG level Calculus and Differential Equations.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first ODE</td><td>Lec. Hrs.</td><td>Cos</td><td>Cognitive Level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="3">UNIT-I: Linear equations with constant coefficients: Introduction- Second order homogeneous equation- Initial value problems for second order equation-Linear dependence and independence-A formula for the Wronskian -The non-homogeneous equation of order n.
RTB (1): Chapter 2: Sections 1 to 6</td><td>15</td><td>CO-1</td><td>K1
K4
K6</td></tr>
<tr><td colspan="3">UNIT-II: Linear equations with constant coefficients: The homogeneous equation of order n- Initial value problems for n-th order equations- a special method method for solving non-homogeneous equation- Algebra of constant coefficient operators.
RTB (1): Chapter 2: Sections 7,8,11,12.</td><td>17</td><td>CO-2</td><td>K1
K3
K4</td></tr>
<tr><td colspan="3">UNIT-III: Linear equation with variable coefficients Introduction- Initial value problems for homogeneous equation – solutions of the homogeneous equations - the Wronskian and linear independence – reduction of the order of a homogeneous equation – the non-homogeneous equation- homogeneous equations with analytic coefficients-The Legendre equation.
RTB (1): Chapter : 3 Sections 1 to 8 (Omit section 9)</td><td>15</td><td>CO-3</td><td>K1
K6</td></tr>
<tr><td colspan="3">UNIT-IV: Linear equation with regular singular points Euler equation – Second order equations with regular singular points – Exceptional cases – Bessel equation.
RTB (1): Chapter 4: Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9)</td><td>18</td><td>CO-4</td><td>K1
K3</td></tr>
<tr><td colspan="3">UNIT-V: Existence and uniqueness of solutions to first order
equations: Equation with variable separated – Exact equations – method of successive approximations – the Lipschitz condition – convergence of the successive approximations – non-local existence of solutions.</td><td>10</td><td>CO-5</td><td>K1
K5
K6</td></tr>
</table>

	RTB (1): Chapter 5: Sections 1 to 6 (Omit Sections 7 to 9)			
	Total	**75**		

	S. No	**Title of the Books**	**Authors**	**Publishers**	**Reprint Year**
Recommended Text Books (RTB)	1	An introduction to ordinary differential equations (3rd Printing)	E.A. Coddington	Prentice-Hall of India Ltd., New Delhi	2012
Reference Books (RB)	1	Differential Equations with applications and historical notes	George F Simmons	Tata McGraw-Hill Publishing Company	1994
	2	Advanced Differential Equations	M.D. Raisinghania	S. Chand & company Ltd. New Delhi	2001
	3	An introduction to ordinary differential equations	Earl A. Coddington	Dover publications INS. New York	1989
	4	Theory of ordinary differential equations	Earl A. Coddington and Norman Levinson	Tata McGraw-Hill Publishing Company	2008
	5	Linear ordinary differential equations	Earl A. Coddington and Robert Carlson	Library of congress cataloging in publishing data	1997
	6	Ordinary differential Equations	Gerald Teschl	Library of congress cataloging in publishing data	2020
	7	Ordinary differential Equations	S.G. Deo, Lakshmikanthan V. Raghavendra	Tata McGraw-Hill Publishing company	1997

<table>
<tr><td>Title of the Course</td><td colspan="6">Graph Theory and Applications</td></tr>
<tr><td>Paper Number</td><td colspan="6">I</td></tr>
<tr><td>Category</td><td>Elective</td><td>Year
Semester</td><td>I
I</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="6">Basic knowledge of Graphs.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To study and develop the concepts of graph theory.
➢ To learn the importance and its applications.
➢ To approach practically with the help of graph software.
➢ To learn the base knowledge of Research.
➢ To learn the base knowledge of CSIR/SET/PGTRB.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="4">Course Outline</td><td colspan="3">UNIT – I Graphs, Subgraphs and Trees: Graphs and simple graphs – Graph isomorphism – The incidence and adjacency matrices – Subgraphs – Vertex degrees – Path and connection – Cycles – Trees – Cut Edges and Bonds – Cut vertices.
RTB (1): Chapter 1: Sections 1.1 to 1.7
RTB (1): Chapter 2: Sections 2.1 to 2.3</td><td>16</td><td>CO-1</td><td>K1
K3</td></tr>
<tr><td colspan="3">UNIT – II Connectivity, Euler tours and Hamilton Cycles: Connectivity – Blocks – Euler tours – Hamilton Cycles.
RTB (1): Chapter 3: Sections 3.1 to 3.2
RTB (1): Chapter 4: Sections 4.1 to 4.2</td><td>14</td><td>CO-2</td><td>K1
K5
K3</td></tr>
<tr><td colspan="3">UNIT – III Matchings, Edge Coloring: Matchings – Matchings and coverings in bipartite graphs – Edge Chromatic number – Vizing’s theorem.
RTB (1): Chapter 5: Sections 5.1 to 5.2
RTB (1): Chapter 6 : Sections 6.1 to 6.2</td><td>15</td><td>CO-3</td><td>K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT – IV Independent sets and Cliques, Vertex coloring’s: Independent sets – Ramsey’s theorem – Chromatic number – Brook’s theorem – Chromatic polynomials.
RTB (1): Chapter 7: Sections 7.1 to 7.2
RTB (1): Chapter 8: Sections 8.1 to 8.2, 8.4</td><td>15</td><td>CO-3
CO-4</td><td>K1
K2
K5</td></tr>
<tr><td colspan="3">UNIT – V Planar Graphs: Plane and planar graphs – Dual graphs – Euler’s formula – The five – color theorem and the Four – color</td><td>15</td><td>CO-5</td><td>K1
K3</td></tr>
</table>

	conjecture. **RTB (1): Chapter 9: Sections 9.1 to 9.3, 9.6**			
	Total	**75**		

Recommended Text Books (RTB)	**S.No**	**Title of the Books**	**Authors**	**Publishers**	**Reprint Year**
	1	Graph Theory with Applications	J.A. Bondy and U.S.R Murty	Macmillan, London	1976
Reference Books (RB)	1	Basic Graph Theory,	K.R. Parthasarathy	Tata McGraw-Hill, New Delhi	1994
	2	Narsingh Deo	Graph Theory with Applications to Engineering and Computer Science	Prentice-Hall of India	2007
	3	Douglas B. West	Introduction to Graph Theory	Pearson Prentice Hall	2006

<table>
<tr><td>Title of the Course</td><td colspan="7">OPERATIONS RESEARCH</td></tr>
<tr><td>Paper Number</td><td colspan="7">II</td></tr>
<tr><td>Category</td><td>Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td></td><td></td><td>Semester</td><td>I</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="7">Basic knowledge of Operations Research</td></tr>
<tr><td>Objectives</td><td colspan="4">➢ To learn about basic ideas of Operation Research.
➢ To teach the basic concepts of basic Operation research.
➢ To enlighten the students in the field.
➢ To learn the base knowledge of Research.
➢ To learn the base knowledge of CSIR/SET/PGTRB.</td><td>Re</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="3">Course Outline</td><td colspan="4">UNIT-I: Decision Theory: Steps in Decision theory Approach –
Types of Decision-Making Environments – Decision Making Under Uncertainty – Decision Making under Risk – Posterior Probabilities and Bayesian Analysis – Decision Tree Analysis – Decision Making with Utilities.
RTB (2): Chapter 11</td><td>16</td><td>CO-1</td><td>K1
K3</td></tr>
<tr><td colspan="4">UNIT-II: Network Models: Scope of Network Applications – Network Definition – Minimal spanning true Algorithm – Shortest Route problem – Maximum flow model – Minimum cost capacitated flow problem- Network representation – Linear Programming formulation – Capacitated Network simplex Algorithm.
RTB (1): Chapter 6: Section 6.1 to 6.6</td><td>14</td><td>CO-2</td><td>K1
K5
K3</td></tr>
<tr><td colspan="4">UNIT-III: Deterministic Inventory Control Models: Meaning of Inventory Control–Functional Classification – Advantage of Carrying Inventory –Features of Inventory System – Inventory Model building- Deterministic Inventory Models with no shortage – Deterministic Inventory with Shortages Probabilistic Inventory Control Models: Single Period Probabilistic Models without Setup cost – Single Period Probabilities Model with Setup cost.
RTB (1): Chapter14: Sec.14.1 to 14.8
Chapter15: Sec 15.1 to 15.3</td><td>15</td><td>CO-3</td><td>K1
K5
K6</td></tr>
</table>

	UNIT-IV: Queueing Theory: Essential Features of Queueing System–Operating Characteristic of Queueing System– Probabilistic Distribution in Queueing Systems– Classification of Queueing Models – Solution of Queueing Models – Probability Distribution of Arrivals and Departures– Erlangian Service times Distribution with k-Phases. **RTB (1): Chapter1:Sec.16.1 to 16.8**	15	CO-3 CO-4	K1 K2 K5
	UNIT-V: Replacement and Maintenance Models: Failure Mechanism of items – Replacement of Items that deteriorate with Time – Replacement of items that fail completely – Other Replacement Problems. **RTB (1): Chapter17: Sec.17.1 to 17.5**	15	CO-5	K1 K3
	Total	75		

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Operations Research. 6th edition	(For Unit 2): H.A. Taha	PrenticeHallof India	1998
	2	Operations Research	(For all other Units): J.K. Sharma	MacMillan India, New Delhi	2001
Reference Books (RB)	1	Introduction To Operations Research (7th Edition)	F.S. Hiller and J. Lieberman	Tata McGraw Hill Publishing Company, New Delhi	2001
	2	Foundations of Optimization (2nd Edition)	Beightler.C, D. Phillips, B. Wilde	Prentice Hall Pvt Ltd., New York	1979
	3	Linear Programming and Network flow	Bazaraa, M. S; J. J. Jarvis, H.D. Sharall	John Wiley and sons, New York	1990
	4	Fundamentals of Queueing Theory (3rd Edition)	. Gross, D and C.M. Harris	Wiley and Sons, New York	1998

<table>
<tr><td>Title of the Course</td><td colspan="8">Advanced Algebra</td></tr>
<tr><td>Paper Number</td><td colspan="8">IV</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td>Semester</td><td>II</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Pre-Requisite</td><td colspan="8">Basic Knowledge of Polynomials.</td></tr>
<tr><td>Objectives</td><td colspan="5">➢ To attain the depth knowledge about the algebraic structure of fields.
➢ To provide the use of Galois theory in discussing the existence of roots of the polynomial.
➢ To learn about the concepts of fields.
➢ To learn the base knowledge of Research.
➢ To learn the base knowledge of CSIR/SET/PGTRB.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="5">UNIT-I
UNIT-I: Extension fields – Transcendence of e.
RTB (1): Chapter 5: Section 5.1 and 5.2</td><td>16</td><td>CO-1
CO-4</td><td>K1
K3</td></tr>
<tr><td colspan="5">UNIT-II: Roots or Polynomials. - More about roots
RTB (1): Chapter 5: Sections 5.3 and 5.5</td><td>15</td><td>CO-2
CO-4</td><td>K1
K6</td></tr>
<tr><td colspan="5">UNIT-III: Elements of Galois theory.
RTB (1): Chapter 5: Section 5.6</td><td>14</td><td>CO-1
CO-2</td><td>K1
K6</td></tr>
<tr><td colspan="5">UNIT-IV: Finite fields - Wedderburn’s theorem on finite division rings.
RTB (1): Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)</td><td>15</td><td>CO-1
CO-3
CO-4</td><td>K1
K3</td></tr>
<tr><td colspan="5">UNIT-V: Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.
RTB (1): Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)
Chapter 7: Sections 7.3 and 7.4</td><td>15</td><td>CO-2
CO-5</td><td>K1
K3
K5</td></tr>
<tr><td></td><td colspan="5">Total</td><td>75</td><td></td><td></td></tr>
</table>

	S. No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Topics in Algebra (II Edition)	I.N. Herstein	Wiley Eastern Limited, New Delhi	2016
Reference Books (RB)	1	Algebra	Michael Artin	Prentice Hall	1991
	2	Algebra I & II	I.S. Luther and I.B.S. Passi	Narosha Publishing House, New Delhi	1999
	3	Abstract Algebra Third Edition	David S. Dummit and Richard M. Foote	Wiley Publications	2014
	4	Contemporary Abstract Algebra Fourth Edition	Joseph A. Gallian	Narosa Publishing House Pvt. Ltd.	1999
	5	Basic Abstract Algebra (II Edition)	P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul	Cambridge University Press	1997
	6	Basic Algebra I & II	N. Jacobson and W.H. Freeman	Hindustan Publishing Company, New Delhi	1980
	7	Fundamental of Abstract Algebra	D.S Malik, J. N. Mordeson and M.K. Sen	McGraw Hill (International Edition), New York	1997

<table>
<tr><td>Title of the Course</td><td colspan="6">Real Analysis II</td><td></td><td></td><td></td></tr>
<tr><td>Paper Number</td><td colspan="6">V</td><td></td><td></td><td></td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>I
II</td><td>Credits</td><td>5</td><td>Course Code</td><td></td><td></td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="6">Basic knowledge about Calculus.</td><td></td><td></td><td></td></tr>
<tr><td>Objectives</td><td colspan="6">➢ To introduce Fourier Series and Integrals.
➢ To learn the base knowledge of CSIR/SET/PG-TRB.
➢ To learn the base knowledge for Research.</td><td>Lect. Hrs</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="3">Course Outline</td><td colspan="6">UNIT-I: Measure on the Real line - Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability
RTB (1): Chapter - 2 Sec 2.1 to 2.5 (de Barra)</td><td>14</td><td>CO-1</td><td>K1
K3
K4</td></tr>
<tr><td colspan="6">UNIT-II: Integration of Functions of a Real variable - Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals
RTB (1): Chapter - 3 Sec 3.1,3.2 and 3.4 (de Barra)</td><td>15</td><td>CO-1
CO-5</td><td>K1
K4
K6</td></tr>
<tr><td colspan="6">UNIT-III: Fourier Series and Fourier Integrals - Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system -
Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann’s localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem</td><td>15</td><td>CO-2
CO-4</td><td>K1
K5
K6</td></tr>
</table>

	RTB (2): Chapter 11: Sections 11.1 to 11.15 (Apostol)			
	UNIT-IV: Multivariable Differential Calculus - Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1. **RTB (2): Chapter 12: Section 12.1 to 12.14 (Apostol)**	16	CO-2 CO-3 CO-5	K1 K4 K6
	UNIT-V: Implicit Functions and Extremum Problems: Introduction - Functions with non-zero Jacobian determinants – The inverse function theorem- The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions. **RTB (2): Chapter 13: Sections 13.1 to 13.7 (Apostol)**	15	CO-3 CO-4	K1 K3 K5
	Total	**75**		

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Measure Theory and Integration	G. de Barra,	Wiley Eastern Ltd., New Delhi,	1981
	2	Mathematical Analysis, 2nd Edition	Tom Apostol	Addison-Wesley Publishing Company Inc. New York	1974
Reference Books (RB)	1	Principles of Mathematical Analysis	Walter Rudin	McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013
	2	Principles of Real Analysis	S. C. Malik	New Age International (Pvt.) Ltd.	2011
	3	Real Analysis	Bartle R. G	John Wiley and Sons Inc.	1976
	4	Real Analysis	H. L Royden	P. M. Fitzpatrick (4^{th} Edition)	2010
	5	Methods of Real Analysis	Richard R. Goldberg	Oxford & IBH Publishing Company	2017
	6	Introduction to Real Analysis	Sanjay Arora and Bansi Lal	Satya Prakashan, New Delhi	1991
	7	Principles of Real Analysis	A.L. Gupta and N.R. Gupta	Pearson Education, (Indian print)	2003

<table>
<tr><td>Title of the Course</td><td colspan="7">Partial differential equations</td></tr>
<tr><td>Paper Number</td><td colspan="7">VI</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>I</td><td>Credits</td><td>4</td><td>Course Code</td><td></td></tr>
<tr><td></td><td></td><td>Semester</td><td>II</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="7">UG level partial differential equations</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To classify the second order partial differential equations.
➢ To study Cauchy problem, method of separation of variables, boundary value problems.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive level</td></tr>
<tr><td rowspan="4">Course Outline</td><td colspan="3">UNIT-I
Partial Differential Equations of First Order: Formation and
solution of PDE- Integral surfaces – Cauchy Problem order eqn Orthogonal surfaces – First order non-linear – Characteristics – Compatible system – Charpit method. Fundamentals: Classification and canonical forms of PDE.
RTB (1): Chapter 0: 0.4 to 0.11 (omit 0 .1,0.2,0.3 and 0.11.1)
RTB (1): Chapter 1: 1.1 to 1.5</td><td>17</td><td>CO-1</td><td>K1
K3
K5</td></tr>
<tr><td colspan="3">UNIT-II
Elliptic Differential Equations: Derivation of Laplace and Poisson equation – BVP – Separation of Variables – Dirichlet’s Problem and Newmann Problem for a rectangle – Interior and Exterior Dirichlet’s problems for a circle – Interior Newmann problem for a circle – Solution of Laplace equation in Cylindrical – Examples.
RTB (1): Chapter 2: 2.1, 2. 2 ,2.5 to 2.11&2.13 (omit 2.3 and 2.4 & 2.12 and Examples)</td><td>15</td><td>CO-1
CO-2</td><td>K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT-III
Parabolic Differential Equations: Formation and solution of Diffusion equation – Dirac-Delta function – Separation of variables method – Solution of Diffusion Equation in Cylindrical.
RTB (1): Chapter 3: 3.1 to 3.6 and 3.9 (omit 3.7,3.8 & 3.10)</td><td>18</td><td>CO-3</td><td>K1
K3
K5</td></tr>
<tr><td colspan="3">UNIT-IV</td><td>14</td><td>CO-5</td><td>K1
K4</td></tr>
</table>

	Hyperbolic Differential equations: Formation and solution of one-dimensional wave equation – canonical reduction – IVP- d'Alembert's solution – Vibrating string – Forced Vibration – IVP and BVP for two-dimensional wave equation – Periodic solution of one-dimensional wave equation in cylindrical and spherical coordinate systems – vibration of circular membrane – Uniqueness of the solution for the wave equation **RTB (1): Chapter 4: 4.1 to 4.8,4.10&4.11(omit 4.9 ,4.12 & 4.13)**			K6
	UNIT-V **Green's Function:** Green's function for LaPlace Equation – methods of Images – Eigen function Method – Green's function for the wave and Diffusion equations. Laplace Transform method: Solution of Diffusion and Wave equation by Laplace Transform. **RTB (1): Chapter 5: 5.1 to 5.6** **RTB (1): Chapter 6: 6.13.1 and 6.13.2 only (omit (6.14)**	11	CO-4 CO-5	K1 K3 K5
	Total	**75**		

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Introduction to Partial Differential Equations, 3rd Edition,	K. Sankar Rao	Prentice Hall of India, New Delhi.	2015
Reference Books (RB)	1	Transforms and Partial Differential Equations	T. Veerarajan	Tata McGraw-Hill Publishing Company	2012
	2	Partial Differential Equations 4th Edition	R.K. Gupta	Krishna Prakashan Media Pvt. Ltd.	2012
	3	Ordinary and Partial Differential Equations	M.D. Raisinghania	S. Chand and company Limited	2017
	4	Partial Differential Equations (second edition)	Lawence C. Evans	American mathematical society	2015
	5	Introduction to Partial Differential Equations with applications	E.C. Zachmanoglou	Dover publications	1976
	6	Introduction to Partial Differential Equations	Peter j. Olver	Springer	2013
	7	Introduction to Partial Differential Equations (3rd Edition)	K. Sankara Rao	PHI Learning Pvt. Ltd.	2013

Title of the Course	**Tensor Analysis and Relativity**						
Paper Number	III						
Category	Elective	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				
Pre-Requisite	Basic knowledge of Groups.						
Objectives	➢ To study and develop the concepts of Tensor Algebra. ➢ To learn the basic theorems of Riemann space. ➢ To understand various canonical forms of transformations. ➢ To learn the base knowledge of Relativity. ➢ To learn the base knowledge of CSIR/SET/PGTRB.					**Lect. Hrs.**	**COs**	**Cognitive Level**
Course Outline	**UNIT-I : Tensor Algebra :** Systems of Different orders – Summation Convention – Kronecker Symbols – Examples – Exercise - Transformation of coordinates in Sn - Invariants – Covariant and Contravariant vectors - Tensors of Second Order – Mixed Tensors – Zero Tensor – Tensor Field – Algebra of Tensors – Equality of Tensors – Symmetric and Skew-symmetric tensors - Outer multiplication, Contraction and Inner Multiplication – Quotient Law of Tensors – Reciprocal Tensor – Relative Tensor – Cross Product of Vectors - Examples – Exercise. **RTB (1): Chapter I: I.1 – I.3, I.7 and I.8 and Chapter II: II.2 – II.19**					16	CO-1	K1 K3
	UNIT-II: Tensor Calculus: Riemannian Space – Christoffel Symbols and their properties. **RTB (1): Chapter III: III.1 and III.2**					14	CO-2	K1 K5 K3
	UNIT-III: Tensor Calculus(contd): Covariant Differentiation of Tensors – Riemann–Christoffel Curvature Tensor – Intrinsic Differentiation **RTB(1): Chapter III: III.3 – III.5**					15	CO-3	K1 K5 K6
	UNIT-IV: Special Theory of Relativity: Galilean Transformations – Maxwell's equations – The					15	CO-3 CO-4	K1 K2

	ether Theory – The Principle of Relativity. Relativistic Kinematics: Lorentz Transformation equations – Events and simultaneity – Example – Einstein Train – Time dilation – Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example – twin paradox – addition of velocities – Relativistic Doppler effect. **RTB (2): Chapter 7: Sections 7.1 and 7.2**			K5
	UNIT-V: Relativistic Dynamics: Momentum – Energy – Momentum – energy four vector – Force - Conservation of Energy – Mass and energy – Example – inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations. Accelerated Systems: Rocket with constant acceleration – example – Rocket with constant thrust**.** **RTB (2): Chapter 7: Sections 7.3 and 7.4**	15	CO-5	K1 K3
	Total	**75**		

Recommended Text Books for Units I, II and III (RTB)	**S.No**	**Title of the Books**	**Authors**	**Publishers**	**Reprint Year**
	1	Tensor Calculus	U.C. De, Absos Ali Shaikh and Joydeep Sengupta	Narosa Publishing House, New Delhi,	2004
For Units IV and V	2	Classical Dynamics	D. Greenwood	Prentice Hall of India, New Delhi	1985
Reference Books (RB)	1	Tensor Calculus	J.L. Synge and A. Schild	Toronto	1949
	2	The Mathematical Theory of Relativity	A.S. Eddington	Cambridge University Press	1930
	3	An Introduction to Theory of Relativity	P.G. Bergman	New York	1942
	4	Riemannian Geometry and the Tensor Calculus	C.E. Weatherburn	Cambridge	1938

<table>
<tr><td>Title of the Course</td><td colspan="7">Java</td></tr>
<tr><td>Paper Number</td><td colspan="7">IV</td></tr>
<tr><td>Category</td><td>Elective</td><td>Year
Semester</td><td>I
II</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="7">Basic knowledge about computer programming.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To study and develop the concepts of Java
➢ Data analysis and its applications.</td><td>Lect. Hrs.</td><td>COs</td><td colspan="2">Cognitive Level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="3">UNIT – I: Overview of Java Language: Java Tokens – Java Statements.
Chapter 3: Section 3.1 to 3.12</td><td>16</td><td>CO-1</td><td colspan="2">K1
K3</td></tr>
<tr><td colspan="3">UNIT – II: Constants – Variables – Data Types
Chapter 4: Section 4.1 to 4.12</td><td>14</td><td>CO-2</td><td colspan="2">K1
K5
K3</td></tr>
<tr><td colspan="3">UNIT – III: Operators - Expressions
Chapter 5: Section 5.1 to 5.16</td><td>15</td><td>CO-3</td><td colspan="2">K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT – IV: Decision making and Branching
Chapter 6: Section 6.1 – 6.9</td><td>15</td><td>CO-3
CO-4</td><td colspan="2">K1
K2
K5</td></tr>
<tr><td colspan="3">UNIT – V: Classes – Objects – Methods – Arrays – Strings
Chapter 8: Section 8.1 to 8.19
Chapter 9: Section 9.1 to 9.5</td><td>15</td><td>CO-5</td><td colspan="2">K1
K3</td></tr>
<tr><td></td><td colspan="3">Total</td><td>75</td><td></td><td colspan="2"></td></tr>
</table>

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Programming with Java	E. Bala Guruswamy,	A primer, Tata McGraw Hill Publishing Company Limited, New Delhi, 1	2010

<table>
<tr><td>Title of the Course</td><td colspan="6">Complex Analysis</td></tr>
<tr><td>Paper Number</td><td colspan="6">VII</td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>II
III</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="6">Basic knowledge about Real analysis.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To introduce measure on the real line.
➢ To learn Cauchy’s integral and Integrability.
➢ To teach the concept of measure sets and functions.
➢ To study the mapping and weistrass theorem.
➢ To learn the base knowledge of Research.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive level</td></tr>
<tr><td rowspan="4">Course Outline</td><td colspan="3">UNIT-I: Cauchy’s Integral Formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions: Removable Singularities-Taylors’s Theorem – Zeros and poles – The local Mapping – The Maximum Principle.
RTB (1): Chapter 4: Section 2: 2.1 to 2.3
Chapter 4: Section 3: 3.1 to 3.4</td><td>15</td><td>CO-1
CO-4</td><td>K1
K3
K5</td></tr>
<tr><td colspan="3">UNIT-II: The general form of Cauchy’s Theorem: Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy’s Theorem - Proof of Cauchy’s theorem - Locally exact differentials- Multiply connected regions - Residue theorem - The argument principle.
RTB (1): Chapter 4: Section 4: 4.1 to 4.7
Chapter 4: Section 5: 5.1 and 5.2</td><td>15</td><td>CO-3
CO-4</td><td>K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT-III: Riemann mapping Theorem: Statement and Proof – Boundary Behaviour – Use of the Reflection Principle. Conformal mappings of polygons: Behaviour at an angle Schwarz-Christoffel formula – Mapping of a rectangle. Harmonic Functions: Functions with mean value property – Harnack’s principle.
RTB (1): Chapter 6: Sections 1.1 to 1.3 (Omit Section1.4), Sections 2.1 to 2.3 (Omit section 2.4), Section 3.1 and 3.2</td><td>14</td><td>CO-3
CO-4</td><td>K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT-IV: Weierstrass Theory: The Weierstrass $\wp$-function – The functions ζ(s) and σ(s) – The differential equation – The modular equation $\lambda(\tau)$ – The Conformal mapping by $\lambda(\tau)$
RTB (1): Chapter 7: Sections 3.1 to 3.5</td><td>15</td><td>CO-2</td><td>K1
K5</td></tr>
</table>

	UNIT-V: Analytic Continuation: The Weierstrass Theory – Germs and Sheaves – Sections and Riemann surfaces – Analytic continuation along Arcs – Homotopic curves – The Monodromy Theorem – Branch points. **RTB (1): Chapter 8: Sections 1.1 to 1.7**	16	CO-1 CO-3 CO-5	K1 K3 K6
	Total	**75**		

	S. No	**Title of the Books**	**Authors**	**Publishers**	**Reprint Year**
Recommended Text Books (RTB)	1	Complex Analysis	Lars V. Ahlfors	McGraw Hill Co., New York	2013
Reference Books (RB)	1	Complex Analysis	T.W. Gamelin	Springer International Edition	2001
	2	Introduction to Complex Analysis	H.A. Priestly	Clarendon Press, Oxford.	2003
	3	Notes on Complex function Theory	D. Sarason	Hindustan Book Agency	1998
	4	Functions of one complex variable	J.B. Conway	Springer International Edition	2003
	5	Complex Variables: Theory and Applications	H. S. Kasana	Prentice Hall	2005
	6	Complex Variables	M. R. Spiegel	McGraw Hill Book Company	1974
	7	Complex Variables and Applications	J. W. Brown, R.V. Churchill	McGraw Hill	2009

<table>
<tr><td>Title of the Course</td><td colspan="6">Probability Theory</td></tr>
<tr><td>Paper Number</td><td colspan="6">XIII</td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>II
III</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="6">Basic knowledge of probability and statistics.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To study and develop the concepts of Probability theory.
➢ To understand various parameters of distributions.
➢ To learn the base knowledge of Research.
➢ To learn the base knowledge of CSIR/SET/PGTRB.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="4">Course Outline</td><td colspan="3">UNIT – I Random Events and Random Variables: Random events – Probability axioms – Combinatorial formulae – Conditional probability – Bayes theorem – Independent events – Random variables – Distribution function – Joint distribution – Marginal distribution – Conditional distribution – Independent random variables – Functions of random variables.
RTB (1): Chapter 1: Sections 1.1 to 1.7
RTB (1): Chapter 2: Sections 2.1 to 2.9</td><td>16</td><td>CO-1</td><td>K1
K3</td></tr>
<tr><td colspan="3">UNIT – II: Parameters of the Distribution: Expectation – Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.
RTB (1): Chapter 3: Sections 3.1 to 3.8</td><td>14</td><td>CO-2</td><td>K1
K5
K3</td></tr>
<tr><td colspan="3">UNIT – III Characteristic Functions: Properties of characteristic functions - Characteristic functions and moments – Semi invariants – Characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions
RTB (1): Chapter 4: Sections 4.1 to 4.7</td><td>15</td><td>CO-3</td><td>K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT – IV Some Probability distribution: One point, two-point, Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – Normal gamma – Beta – Cauchy and Laplace (continuous)</td><td>15</td><td>CO-3
CO-4</td><td>K1
K2
K5</td></tr>
</table>

	distribution. **RTB (1): Chapter 5: Section 5.1 to 5.10**			
	UNIT – V Limit Theorems: Stochastic convergence – Bernoulli **l**aw of large numbers – Convergence of sequence of distribution functions – Levy – Cramer theorems – de Moivre – Laplace theorem – Poisson, Chebyshev, Khintchine weak law of large numbers – Lindberg theorem – lapunov theorem – Borel – Cantelli lemma - Kolmogorov inequality and Kolmogorov strong law of large numbers. **RTB (1): Chapter 6: Sections 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12**	15	CO-5	K1 K3
	Total	**75**		

	S.No	**Title of the Books**	**Authors**	**Publishers**	**Reprint Year**
Recommended Text Books (RTB)	1	Probability Theory and Mathematical Statistics, Third edition	M. Fisz	John Wiley and Sons, New York	1963
Reference Books (RB)	1	Real Analysis and Probability	R.B. Ash	Academic Press, New York	1972
	2	Probability: Theory and Examples, [2nd Edition]	R. Durrett	Duxpury Press, New York	1996
	3	An Introduction to Probability: Theory and Mathematical Statistics, [3rd Print]	V.K. Rohatgi	Weiley Eastern Ltd., New Delhi	1988
	4	A Probability Path	S.I. Resnick	Birhauser, Berlin	1999
	5	Modern Probability Theory, [3rd Edition]	B.R. Bhat	New Age International (P) Ltd, New Delhi	1999

<table>
<tr><td>Title of the Course</td><td colspan="7">Topology</td></tr>
<tr><td>Paper Number</td><td colspan="7">IX</td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>II
III</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="7">The Basic Real and Complex knowledge.</td></tr>
<tr><td>Objectives</td><td colspan="4">➢ To learn about basic knowledge of topology.
➢ To learn the basic analysis in topological spaces.
➢ To learn the metric spaces in topological spaces.
➢ To learn the base knowledge of Research.
➢ To learn the base knowledge of CSIR/SET/PGTRB</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="4">UNIT-I: Topological spaces: Topological spaces – Basis for a topology – The order topology – The product topology on X × Y – The subspace topology – Closed sets and limit points.
RTB (1): Chapter 2: Sections 12 to 17</td><td>20</td><td>CO-1</td><td>K1
K4
K6</td></tr>
<tr><td colspan="4">UNIT-II: Continuous functions: Continuous functions – the product topology – The metric topology.
RTB (1): Chapter 2: Sections 18 to 21 (Omit Section 22)</td><td>15</td><td>CO-2</td><td>K1
K3
K5</td></tr>
<tr><td colspan="4">UNIT-III: Connectedness: Connected spaces-connected subspaces of the Real line – Components and local connectedness.
RTB (1): Chapter 3: Sections 23 to 25.</td><td>20</td><td>CO-3
CO-5</td><td>K1
K4
K6</td></tr>
<tr><td colspan="4">UNIT-IV: Compactness: Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness.
RTB (1): Chapter 3: Sections 26 to 29.</td><td>10</td><td>CO-2</td><td>K1
K5
K6</td></tr>
<tr><td colspan="4">UNIT-V: Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietz extension theorem.
RTB (1): Chapter 4: Sections 30 to 35.</td><td>10</td><td>CO-4</td><td>K1
K3
K5</td></tr>
<tr><td></td><td colspan="4">Total</td><td>75</td><td></td><td></td></tr>
</table>

	S. No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Topology (2nd Edition) (Third Indian Reprint)	James R. Munkres	Pearson Education Pvt. Ltd., Delhi	2012
Reference Books (RB)	1	Topology	K. Chandrasekhara Rao	Narosa Publishing House	2012
	2	Essential of Topology with Application	S. G. Krantz	CRC Press	2015
	3	Topology	N. Sharma, Chauhan	Krishna Prakashan Media (Pvt.) Ltd	2013
	4	General Topology	J. L. Kelley	Springer	2009
	5	Topology	J.R. Munkres	PHI Learning Pvt. Ltd.	2013
	6	Foundations of Topology	C. Wayne Patty	Jones and Bartlett Publishers	2012
	7	General Topology	S. Willard	Addison Wesley	2007

Title of the Course	Statistical Methods								
Paper Number	X								
Category	Core	Year	II	Credits	4	Course Code			
		Semester	III						
Pre-Requisite	An introduction to Applied statistics.								
Objectives	➢ To know the applications of Statistical Quality Control. ➢ To understand about Acceptance Sampling plans. ➢ To Define and understand Design of experiments. ➢ To learn the base knowledge of Research. ➢ To learn the base knowledge of SET.						**Lect. Hrs.**	**COs**	**Cognitive level**
Course Outline	**UNIT I –** I: Introduction to Statistical Quality Control – Control Charts- Types of Control Charts – $\bar{X}$, R, P, C - Total Quality Management. Acceptance sampling plans- Role-Types of Sampling –Single Sampling Plan – Double Sampling Plan – OC Curves – AQL and LTPD plans. **RTB (1): Chapter 7 : Page no: 1079 – 1108.**						20	CO-1	K1 K2 K6
	UNIT-II: Index Number -Uses – Classification – problems in Construction of Index Number – Methods of Construction Index Number – Quantity Index Number – Value Index Number – Tests of Adequacy – Chain Index Number – Base Shifting-Splicing and Deflating Index Number – Consumer Price Index Number. **RTB (1): Chapter 13: Page no: 535-580.**						15	CO-2 CO-3	K1 K6
	UNIT-III: Analysis of Time Series – Components – Measurement of Trend – Method of Semi-Average-Method of Moving Averages- Method of Least Squares, Measurement of Seasonal Variations – Method of Simple Average – Ratio to trend method-Ratio to moving Average method – Link Relative method. **RTB (1): Chapter 14: Page no: 611-664.**						15	CO-4	K1 K4 K6
	UNIT – IV: Design of Experiments- Introduction – three principles of experimental design - Complete Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), 2^2vdesign, Yates method of computing Factorial effect totals, 2^3 Factorial Experiments, 2^n Factorial experiments. **RTB (2): Chapter 6: 6.1,6.2,6.3,6.4,6.5,6.6,6.9**.						10	CO-2 CO-5	K1 K4 K6
	UNIT-V: Statistical Introduction theory – Introduction – Ingredients of decision problem –						15	CO-4	K1 K3

	Optimal decisions- Decision Tree Analysis-Steps indecision Tree Analysis-Advantage of Decision Tree approach. **RTB (1): Chapter 10: Page. No: 1167-1189**.			K5
	Total	75		

	S. No	**Title of the Books**	**Authors**	**Publishers**	**Reprint Year**
Recommended Text Books (RTB)	1.	Statistical Methods	S.P. Gupta	Sultan Chand &Sons, Educational Publishers, New Delhi	2018
	2	Fundamentals of Applied Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand & sons	2008
Reference Books (RB)	1.	Introduction of Statistical Quality Control	Montgomery	John Wiley and Sons	1991
	2.	Business Statistics	S.L. Aggarwal	Kalyani Publishers	2018
	3.	Business Statistics	Dr. H. Premraj	Margham Publications	2018
	4.	Business Statistics	S.P. Gupta, M.P. Gupta	Sultan Chand & sons	1998

<table>
<tr><td>Title of the Course</td><td colspan="7">Fluid Dynamics</td></tr>
<tr><td>Paper Number</td><td colspan="7">V</td></tr>
<tr><td>Category</td><td>Elective</td><td>Year
Semester</td><td>II
III</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="7">Basic knowledge of Mechanics.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To study and develop the concepts of Kinematics.
➢ To learn the importance of two and three dimensional and its applications.
➢ To learn the base knowledge of Research.
➢ To learn the base knowledge of CSIR/SET/PGTRB.</td><td>Lect. Hrs</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="3">UNIT-I: Kinematics of Fluids in motion. Real fluids and Ideal Fluids-Velocity of a fluid at a point Stream lines, path lines, steady and un steady flows-Velocity potential - The vorticity vector-Local and particle rates of changes-Equations of continuity-Worked Examples-Acceleration of a fluid -Condition satarigid boundary.
RTB (1): Chapter 2: Sec 2.1to2.10.</td><td>16</td><td>CO-1</td><td>K1
K3</td></tr>
<tr><td colspan="3">UNIT-II: Equations of motion of a fluid: Pressure at a point in a fluid at rest. - Pressure at a point in a moving fluid - Conditions at a boundary of two inviscid immiscible fluids-Euler’s equation of motion - Discussion of the case of steady motion under conservative body forces.
RTB (1): Chapter 3: Sec 3.1 to 3.4, 3.7</td><td>14</td><td>CO-2</td><td>K1
K5
K3</td></tr>
<tr><td colspan="3">UNIT-III: Some three-dimensional flows. Introduction-Sources, sinks and doublets - Images in a rigid infinite plane -Axis symmetric flows – Stokes stream function
RTB (1): Chapter 4: Sec 4.1,4.2,4.3,4.5.</td><td>15</td><td>CO-3</td><td>K1
K5
K6</td></tr>
<tr><td colspan="3">UNIT-IV: Some two-dimensional flows: Meaning of two-dimensional flow- Use of Cylindrical polar coordinates - The stream function - The complex potential for two dimensional, irrotational incompressible flow -Complex velocity potentials for standard two-dimensional flows-Some worked examples - Two-dimensional Image systems -The Milne Thompson circle Theorem.
RTB (1): Chapter 5: Sec 5.1to5.8</td><td>15</td><td>CO-3
CO-4</td><td>K1
K2
K5</td></tr>
<tr><td colspan="3">UNIT-V Viscous flows: Stress components in a real fluid. - Relations between Cartesian components of stress-Translational motion of fluid elements – The rate of strain quadric and principal stresses -Some further properties of the rate of strain quadric -Stress analysis in fluid motion - Relation between stress and Rate of strain-The coefficient of viscosity and Laminar flow-The Navier– Stokes equations of motion of a Viscous fluid.
RTB (1): Chapter 8: Sec 8.1 to 8.9</td><td>15</td><td>CO-5</td><td>K1
K3</td></tr>
<tr><td></td><td colspan="3">Total</td><td>75</td><td></td><td></td></tr>
</table>

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Text book of fluid dynamics	F. Chorlton	CBS publications, Delhi	2004
Reference Books (RB)	1	Introduction to Fluid Mechanics	R.W. Foxand, A.T. McDonald	Wiley	1985
	2	Fluid Mechanics with Problems and Solutions	E. Krause	Springer	2005
	3	Mechanics o f Fluids	B.S. Massey, J.W. Smithand A.J.W. Smith	Taylor and Francis, New York	2005
	4	Fluid Flow Phenomena	P. Orlandi	Kluwer, New York	2002
	5	Basics of Fluid Mechanics and Introduction to Computationa l l Fluid Dynamics,	T. Petrila	Springer, berlin	2004

<table>
<tr><td>Title of the Course</td><td colspan="8">Functional Analysis</td></tr>
<tr><td>Paper Number</td><td colspan="8">XI</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>II</td><td>Credits</td><td>5</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td>Semester</td><td>IV</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Pre-Requisite</td><td colspan="8">Basic concepts of Analysis and Algebra.</td></tr>
<tr><td>Objectives</td><td colspan="5">➢ To get ideas about new concepts on functional.
➢ To get basic ideas on embedding of normed linear spaces.
➢ To get thorough knowledge of Banach Algebra.</td><td>Lect. Hrs.</td><td>COs</td><td>Cognitive Level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="5">UNIT-I: Banach Spaces: The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of
N in N** - The open mapping theorem – The conjugate of an Operator.
RTB (1): Chapter 9: Sections 46-51</td><td>12</td><td>CO-1
CO-2</td><td>K1
K4
K6</td></tr>
<tr><td colspan="5">UNIT –II
Hilbert Spaces: The definition and some simple properties–Orthogonal complements–
Orthonormal sets–The conjugate space H*-The adjoint of an operator–self-adjoint operators-
Normal and unitary operators – Projections.
RTB (1): Chapter10: Sections 52-59</td><td>15</td><td>CO-1
CO-2</td><td>K1
K3
K5</td></tr>
<tr><td colspan="5">UNIT-III: Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator –The spectral theorem.
RTB (1): Chapter 11: Sections 60-62</td><td>13</td><td>CO-1
CO-3</td><td>K1
K4
K6</td></tr>
<tr><td colspan="5">UNIT-IV: General Preliminaries on Banach Algebras: The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi-simplicity.
RTB (1): Chapter 12: Sections 64-69</td><td>18</td><td>CO-1
CO-4</td><td>K1
K5
K6</td></tr>
<tr><td colspan="5">UNIT-V: The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula $r(x) = lim\|x^n\|^{\frac{1}{n}}$ -Involution sin Banach algebras-The Gelfand-Neumark theorem.
RTB (1): Chapter 13: Sections 70-73</td><td>17</td><td>CO-1
CO-4
CO-5</td><td>K1
K5</td></tr>
<tr><td></td><td colspan="5">Total</td><td>75</td><td></td><td></td></tr>
</table>

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Introduction to Topology and Modern Analysis	G.F. Simmons	Mc Graw Hill Education (India)Private Limited, New Delhi	2014
Reference Books (RB)	1	A Course in Functional Analysis	J.B. Conway	Springer	2007
	2	Introductory Functional Analysis with Applications	Erwin Kreyszig	Wiley-India	2007
	3	Functional Analysis	W. Rudin	Tata McGraw-Hill Publishing company	1973
	4	Elements of the theory of functions and Functional Analysis	A.N. Kolmogorov, S.V. Fomin	Dover Publication Inc.	1999
	5	Functional Analysis	Balmohan V. Limaye	New Age International Publishers	2014
	6	Functional Analysis	P.K Jain	New Age International Publishers	2019
	7	Functional Analysis	Dr. Sudhir Kumar	CBS Publishers & Distributors	2016

<table>
<tr><td>Title of the Course</td><td colspan="7">Differential Geometry</td></tr>
<tr><td>Paper Number</td><td colspan="7">XII</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>II</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td></td><td></td><td>Semester</td><td>IV</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pre-Requisite</td><td colspan="7">Basic Knowledge of Differentiation and Integration.</td></tr>
<tr><td>Objectives</td><td colspan="4">➢ To lay a broad foundation for an understanding of the problems of the Curves Parametrisations.
➢ To prepare students for the study of Curvature of Surfaces.
➢ To have much better and deeper understanding of the fundamental concepts of the Geodesics.</td><td>Lect. Hrs.</td><td>Cos</td><td>Cognitive level</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="4">UNIT – I: SPACE CURVES
Definition of a space curve-Arc length-tangent- normal and binormal-curvature and torsion-contact between curves and surfaces – tangent surface – involutes and evolutes-Intrinsic equations – Fundamental Existence Theorem for space curves – Helices.
RTB (1): Chapter I: Sections 1 to 9.</td><td>13</td><td>CO-1</td><td>K1
K4
K6</td></tr>
<tr><td colspan="4">UNIT – II: INTRINSIC PROPERTIES OF A SURFACE
Definition of a surface-curves on a surface-surface of revolution-Helicoids-Metric Direction coefficients – families of curves – Isometric correspondence-intrinsic properties.
RTB (1): Chapter II: Sections 1 to 9.</td><td>12</td><td>CO-1
CO-2</td><td>K1
K3
K6</td></tr>
<tr><td colspan="4">UNIT – III: GEODESICS
Geodesics-Canonical geodesic equations- Normal property of geodesics- Existence Theorems – Geodesic parallels.
RTB (1): Chapter II: Sections 10 to 14.</td><td>18</td><td>CO-3
CO-4</td><td>K1
K4
K6</td></tr>
<tr><td colspan="4">UNIT – IV: GEODESICS (Contd…)
Geodesics curvature – Gauss – Bonnet Theorem – Gaussian curvature – surface of constant curvature.
RTB (1): Chapter II: Sections 15 to 18.</td><td>17</td><td>CO-3
CO-4
CO-5</td><td>K1
K4
K6</td></tr>
<tr><td colspan="4">UNIT – V: NON-INTRINSIC PROPERTIES OF A SURFACE
The second fundamental form – Principal Curvature – Lines of Curvature -Developable- Developable associated with space curves and with curves on surface – Minimal Surfaces-Ruled surfaces
RTB (1): Chapter III: Sections 1 to 8.</td><td>13</td><td>CO-3
CO-4
CO-5</td><td>K1
K4
K6</td></tr>
<tr><td></td><td colspan="4">Total</td><td>75</td><td></td><td></td></tr>
</table>

	S. No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	An Introduction to Differential Geometry	T.J. Willmore	Oxford University Press, New Delhi	2002
Reference Books (RB)	1	Elementary Topics in Differential Geometry	J.A. Thorpe	Springer -Verlag	1979
	2	A course in Differential Geometry	Wilhelm Klingenberg	Springer -Verlag	1978
	3	Lectures on classical Differential Geometry	Struik, D. T.	Addison-Wesley, Mass	1950
	4	Differential Geometry of Curves & Surfaces	Manfredo P. Do Carmo	Dover	2016

Title of the Course	**Discrete Mathematics**							
Paper Number	VI							
Category	Elective	**Year**	II	**Credits**	3	**Course Code**		
		Semester	IV					
Pre-Requisite	Basic knowledge of Groups.							
Objectives	➢ To study and develop the concepts of Lattices. ➢ To learn the importance of Switching Circuits and its applications. ➢ To understand Lattices and concept of Coding theory. ➢ To learn the base knowledge of Research. ➢ To learn the base knowledge of CSIR/SET/PGTRB.					**Lect. Hrs.**	**COs**	**Cognitive Level**
Course Outline	**UNIT-I: Lattices:** Properties of Lattices: Lattice definitions–Modular and distributive lattice; Boolean algebras: Basic properties–Boolean polynomials, Ideals; Minimal forms of Boolean polynomials. **RTB (1): Chapter 1: Sec 1A and B, Sec 2 A and B, Sec 3**					16	CO-1	K1 K3
	UNIT-II: Applications of Lattices: Switching Circuits: Basic Definitions -Applications **RTB (1): Chapter 2: Sec 1A and B**					14	CO-2	K1 K5 K3
	UNIT-III: Finite Fields **RTB (1): Chapter 3: Sec 2**					15	CO-3	K1 K5 K6
	UNIT-IV: Polynomials: Irreducible Polynomials over Finite fields – Factorization of Polynomials **RTB (1): Chapter 3: Sec 3 and Sec 4**					15	CO-3 CO-4	K1 K2 K5
	UNIT-V: Coding Theory: Linear Codes and Cyclic Codes **RTB (1): Chapter 4: Sec 1 and 2**					15	CO-5	K1 K3
	Total					**75**		

	S.No	Title of the Books	Authors	Publishers	Reprint Year
Recommended Text Books (RTB)	1	Applied Abstract Algebra	RudolfLidland GunterPilz	Springer – Verlag, New York,	1984
Reference Books (RB)	1	Applied Algebra for Computer Science	A. Gill	Prentice Hall Inc., New Jersey	1976
	2	Mathematical Structures for Computer Science (3rd Edn.)	J.L. Gersting	Computer Science Press, New York	2007
	3	Discrete Mathematics- A Unified Approach	S. Wiitala	Mc Graw Hill Book Co	2008

Group-G

Mathematical Documentation using Latex-Lab

Skill Enhancement Course-I

Semester-I
Internal : 20 Marks
External : 80 Marks
Practical Duration: 3 hours

Objectives:

- To learn the Basics Operations in Latex Program.
- To Get Basic Typing Knowledge in Latex.
- To Get Outputs of Simple to Complex Mathematical Equations and Expressions.

Unit-1 : Matrix

Unit-2 : Graphs

Unit-3 : Tables

Unit-4 : Mathematical Equations

Unit-5 : Images

Recommended Source

Internet Source -1 : https://www.overleaf.com/
Internet Source-2 : https://www.latex-project.org/
Internet Source-3 : https://tex.stackexchange.com/

Computational Mathematics using Sage Math-Lab

Skill Enhancement Course-II

Semester-II
Internal : 20 Marks
External : 80 Marks
Practical Duration: 3 hours

Objectives:

- To learn the Basics about Sage Math.
- To Get Basic Typing Knowledge in Sage Math.
- To Get Outputs of Simple to Complex Mathematical Equations and Expressions.

Unit-1 : Equations

Unit-2 : Curves

Unit-3 : Conic Sections

Unit-4 : Differential Equations

Unit-5 : Vectors

Recommended Source

Internet Source -1 : https://www.sagemath.org/sagebook/english.html.
Internet Source-2 : https://etext.sagepub.in/etext
Internet Source-3 : http://euclid.trentu.ca/math/sb/calculus/Winter-2022/sagebook-ba6596d.pdf

Numerical Analysis using SCILAB-Lab

Skill Enhancement Course-III

Semester-III
Internal : 20 Marks
External : 80 Marks
Practical Duration: 3 hours

Objectives:

- To learn the Basics about SCILAB.
- To Get Basic Typing Knowledge in SCILAB.
- To Get Outputs of Simple to Numerical Mathematical Equations and Expressions.

Unit-1 : Newton Raphson Method

Unit-2 : Bisection Method

Unit-3 : Newton's Method

Unit-4 : Simpson's Rume

Unit-5 : Range kutta Method

Recommended Source

Internet Source -1 : https://www.scilab.org/
Internet Source-2 : https://www.scilab.org/about/scilab-open-source-software
Internet Source-3 : https://www.scilab.org/tutorials/getting-started/first-steps

Differential Equations using SCILAB-Lab

Skill Enhancement Course-IV

Semester-IV
Internal : 20 Marks
External : 80 Marks
Practical Duration: 3 hours

Objectives:

- To learn the Basics about SCILAB.
- To Get Basic Typing Knowledge in SCILAB.
- To Get Outputs of Simple to Differential Equations and Expressions.

Unit-1 : First Order Differential Equations

Unit-2 : Second Order Differential Equation

Unit-3 : Partial Differential Equations

Unit-4 : Differential Equations of Conic sections

Unit-5 : n^{th} Order differential Equations

Recommended Source

Internet Source -1 : https://www.scilab.org/
Internet Source-2 : https://www.scilab.org/about/scilab-open-source-software
Internet Source-3 : https://www.scilab.org/tutorials/getting-started/first-steps

DEPARTMENT OF MATHEMATICS – M.Sc. Programme (2023-2024)

PROGRAMME SPECIFIC OUTCOME

PSO-1. To getting critical and analytic thinking in theoretical aspect

PSO-2. To solving the problem skills in practical aspect

PSO-3. To improve the knowledge, team work presentation skill among the students to do their higher studies in mathematics

PSO-4. To understand the concept of Mathematics and it help to clear the NET/SET/GATE Exams

PSO-5. To getting new ideas basic learning and applying in order to employability.

Algebraic Structures
(Subject Code) Course Outcome

CO-1 To analyses the concept of sylows theorem and its application
CO-2 To understand the concept of Direct Product and Modules
CO-3 Able to learn Different types of transformations
CO-4 To understand the concept of Jordan and Canonical form
CO-5 Depth Knowledge of matrix and its applications

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Algebraic Structures	Unit-1	✓				
	Unit-2		✓			
	Unit-3			✓		
	Unit-4			✓	✓	
	Unit-5					✓

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓		✓	✓	
CO-4	✓		✓	✓	
CO-5	✓		✓	✓	

Real Analysis-I

(Subject Code) Course Outcome

CO-1 To give a thorough knowledge of the various aspects of Real line

CO-2 To Study about this Convergent Sequence, Sub-sequence etc.

CO-3 To develop Analytical thinking and the study of Continuity, Connectivity, Connectedness, Compactness

CO-4 Properties of real valued continuous function

CO-5 Basic knowledge of topology and Metric Space and Rieman - Stieltjes integration

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Real Analysis-I	Unit-1	✓				
	Unit-2			✓		
	Unit-3				✓	
	Unit-4		✓	✓		
	Unit-5					✓

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓		✓	✓	
CO-4	✓		✓	✓	
CO-5	✓		✓	✓	

Ordinary Differential Equations

(Subject Code) Course Outcome

CO-1 Give an in-depth knowledge of solving differential equations

CO-2 Introduce existence and uniqueness theorems in Differential equations. Analysis the analytical properties of a solution of an initial value problem.

CO-3 Different methods of solving ordinary differential equations.

CO-4 Understand the existence of special functions and their properties.

CO-5 Method of solving Bessel's and Legendre differential equations.

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Ordinary Differential Equations	Unit-1	✓				
	Unit-2		✓			
	Unit-3			✓		
	Unit-4				✓	
	Unit-5					✓

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓		✓	✓	
CO-4	✓		✓		
CO-5	✓		✓	✓	

Advanced Algebra

(Subject Code) Course Outcome

CO-1 To introduce the Algebraic structures like Field. Introduction to advance concepts in algebra.

CO-2 To study roots of polynomials and its effect in Galois theory and properties of finite field.

CO-3 To give foundation in Finite fields

CO-4 To train the students in problem-solving as a preparatory to NET/SET.

CO-5 Theoretic Background of Algebraic concepts and problem-solving technique in algebra

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Advanced Algebra	Unit-1	✓			✓	
	Unit-2		✓		✓	
	Unit-3	✓	✓			
	Unit-4		✓	✓	✓	
	Unit-5		✓			✓

PSO- CO MATRIX

Courses Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓				
CO-4	✓				
CO-5	✓			✓	

Real Analysis II

(Subject Code) Course Outcome

CO-1 Introduction about the functions of bounded variation and sequence of functions

CO-2 To learn about the Fourier series and integrals and depth study in multivariable functions

CO-3 To acquire knowledge on differentiation and implicit functions

CO-4 To study about the trigonometric series and extremum problems

CO-5 To get the knowledge about the convergence of series, convergence of a sequence and total derivatives

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Real Analysis – II	Unit-1	✓				
	Unit-2	✓				✓
	Unit-3		✓		✓	
	Unit-4		✓	✓		✓
	Unit-5			✓	✓	

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓			✓	
CO-4	✓		✓	✓	
CO-5	✓			✓	

Partial Differential Equations

(Subject Code) Course Outcome

CO-1 Give detailed knowledge about the integrals of equations.

CO-2 Give an in-depth knowledge of solving Partial Differential equations

CO-3 Introduction of existence and uniqueness theorems in Differential Equations

CO-4 Understand different methods of solving various first order and second order partial differential equations.

CO-5 The applications of second order and higher order partial differential equations in physics.

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Partial Differential Equations	Unit-1	✓				
	Unit-2		✓			
	Unit-3	✓		✓		
	Unit-4		✓		✓	
	Unit-5					✓

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓				
CO-3	✓				
CO-4	✓		✓	✓	
CO-5	✓		✓	✓	

Complex Analysis
(Subject Code) Course Outcome

CO-1 Basic knowledge on entire function
CO-2 Basic knowledge on mapping theorem
CO-3 Basic knowledge on Zeta Function
CO-4 Concepts of Elliptic Function
CO-5 Get brief knowledge on Univalent Function Theory.

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Complex Analysis	Unit-1	✓		✓		
	Unit-2		✓	✓		
	Unit-3		✓	✓		✓
	Unit-4			✓	✓	
	Unit-5		✓	✓		✓

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓				
CO-3	✓				
CO-4	✓		✓	✓	
CO-5	✓		✓	✓	

Probability Theory

(Subject Code)Course Outcome

CO-1 To learn about random variables and random events.

CO-2 To understand the concepts of Parameters of the Distribution.

CO-3 Understand generating functions.

CO-4 Analyses the concept of Probability distributions.

CO-5 To Understand basic limit theorems relating to stochastic convergence.

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Probability Theory	Unit-1	✓				
	Unit-2		✓			
	Unit-3			✓		✓
	Unit-4		✓			
	Unit-5				✓	

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓				
CO-4	✓		✓		
CO-5	✓		✓	✓	

Topology

(Subject Code)Course Outcome

CO-1 To learn about elementary concepts of open bases and Weak topology

CO-2 To understand the concepts of compactness in metric spaces

CO-3 Understand compactness in topological space and separation axioms.

CO-4 Analyses the concept of Harsdorf spaces and problem-solving techniques in topology.

CO-5 Train the students to develop analytical thinking and the study of connectedness and compactness

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Topology	Unit-1	✓				
	Unit-2		✓			
	Unit-3			✓		✓
	Unit-4		✓			
	Unit-5				✓	

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓				
CO-4	✓		✓		
CO-5	✓		✓	✓	

Statistical Methods
(Subject Code) Course Outcome

CO-1 Learn the concept of Statistics and its applications

CO-2 Demonstrate the knowledge of core principles

CO-3 Interpret and consider complex problems.

CO-4 Explore different applications of these concepts in the statistical fields.

CO-5 describes and apply the concept of estimation and distributions.

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Statistical Methods	Unit-1	✓				
	Unit-2	✓	✓			
	Unit-3			✓	✓	
	Unit-4			✓	✓	✓
	Unit-5			✓	✓	✓

PSO- CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓		✓	✓	
CO-4	✓		✓	✓	
CO-5	✓		✓	✓	

Functional Analysis
(Subject Code) Course Outcome

CO-1 Introduce the concept of Functional analysis

CO-2 Learn Hahn Banach theorem and its applications

CO-3 Introduction of Hilbert spaces

CO-4 To understand of preliminaries on Banach Algebra

CO-5 To understand the structure of commutative Banach Algebras.

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Functional Analysis	**Unit-1**	✓	✓			
	Unit-2	✓	✓			
	Unit-3	✓		✓		
	Unit-4	✓			✓	
	Unit-5	✓			✓	✓

PSO-CO MATRIX

Course Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓		
CO-2	✓		✓	✓	
CO-3	✓		✓	✓	
CO-4	✓		✓	✓	
CO-5	✓		✓		

Differential Geometry

(Subject Code) Course Outcome

CO-1 Concept of curves in plane and curve, surface in space and properties of surface

CO-2 Analyses the curvature of surface, geodesics and its applications

CO-3 To understand the concept of theorem for space curves and tangent surface

CO-4 The student will be able to solve the problems about tangent.

CO-5 Used to process and analyses data on metric of a surface

Subject Name	Subject Code	CO-1	CO-2	CO-3	CO-4	CO-5
Differential Geometry	Unit-1	✓		✓		✓
	Unit-2		✓	✓		
	Unit-3	✓		✓		
	Unit-4	✓			✓	
	Unit-5		✓			✓

PSO-CO MATRIX

Course / Subject Code	PSO-1 (Theory)	PSO-2 (Practical)	PSO-3 (Research, Higher studies)	PSO-4 (NET)	PSO-5 (Employment)
CO-1	✓		✓	✓	
CO-2	✓		✓	✓	
CO-3	✓			✓	
CO-4	✓		✓	✓	
CO-5	✓				

Teaching-Learning Process

The program offers many manners of learning and assessment. Students have great freedom of choice of subjects which they can study. The components of teaching-learning process are follows

1. Lectures:

The universal method of communicating knowledge is through lectures. Some of lecture may possible through blackboard, power point presentation and other technologies.

2. Tutorials:

Tutorials resolving difficulties faced by the students in understanding the

lecture. Tutorials are also aimed at solving problems associated with the

concepts discussed during the lectures.

3. Practicals:

It helps to visualize and solving numerical problems in various areas in mathematics. The practical session provides vital insights into mathematical concepts and draw learner's attention towards limitations of numerical computations.

4. Prescribed textbooks:

A large number of books are included in both recommended and references of

each course for enrichment and enhancement of knowledge.

5. E-learning resources:

Understanding Mathematical concepts in the effective manner, leaners can use and access electronic resources and websites.

6. Self-study materials:

By providing Self-study material by the instructors the gap between teaching and learning is fulfilled. Students can get the benefit for preparing examinations.

7. Internships:

Internships makes the students to study and analyze their field. During these internships it is expected that a learner will interact with experts and write a report on a topic provided to the learner.

Assessment Methods

1. Variety of assessment methods that are appropriate will be used to measure the progress towards the course.

2. Priority will be accorded to formative and summative assessments and its development is assessed using time constrained examinations, closed book and open book tests problem-based assignments, observation of practical skills and seminar.

3. Assessment math tests focus on a student's analytical skills and the ability to integrate what they have learned along with creativity with written and oral skills.

4. A teacher can assess the student's real-world understanding and how the analytical processes relate by, in a quiz setting, requesting open responses, like a brief written or oral answer, a mathematical solution, a drawing, a diagram, chart or graph.

5. Process of testing learners in order to better understanding of math.

Keywords

LOCF, CBCS, Course Learning Outcomes, Employability, Graduate Attributes, Communication Skills, Critical Thinking, Recollection, Analyzing, Evaluating, Creating.

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