CHOICE BASED CREDIT SYSTEM
SCHEME & SYLLABUS

M.Sc.(Hons.) Mathematics

Department of Physical Sciences
University Institute of Sciences
SANT BABA BHAG SINGH UNIVERSITY
2021

ABOUT THE DEPARTMENT

The Physical Sciences expands our knowledge of the universe and underlines new technologies, which benefit our society. In keeping with the heritage of imparting quality education, teaching and research are the prime motive of the Department of Physical Sciences.

Department of Physical Sciences is dynamic and progressive in its development of new course initiatives and to contribute substantially to the goal of SBBSU and becoming a research oriented organization. The teaching is by way of interactive sessions between students and teachers. Our courses ensure a coherent degree structure while encouraging interdisciplinary approach.

Student centric, ICT enabled and interactive teaching, outcome based teaching model comprising of theoretical work, regular academic activities such as research projects, seminars, resource learning and hands-on laboratory work.

The Department wishes to focus on providing a comprehensive curriculum at undergraduate and postgraduate levels with teaching- learning adjunct to cater the need of industry, relevant research and career opportunities, meritorious careers in academia and proficient industries. Our research oriented teaching paves the way for entry into different careers since it equips students with advanced transferable skills in information gathering, analysis and presentation, which are vital tools in the field of science.

SALIENT FEATURES OF THE DEPARTMENT

- The department is blessed to have specialized faculty in various fields of Physical Sciences *viz.* Chemistry, Physics, Mathematics.
- The Department keeps its students abreast of latest advancements in technology through ultra-modern computer facilities, e-learning, virtual labs, SWAYAM Courses as per UGC guidelines.
- The department updates curricula on a regular basis to ensure that students keep up with the changing trends of education and research globally. The syllabi of courses are designed to equip students to qualify exams such as GATE, UGC- NET / SLET, TIFR etc.
- The Department has well equipped laboratories with a number of instruments and facilities like, UV- Visible Spectrophotometer, High Speed Centrifuge, Muffle furnance, Digital water bath, Polarimeter, Ultrasonic interferometer, Ballistic Galvanometer **,** Deflection and vibration Magnetometer **,** Electron spin resonance, Turbiditimeter, Abbs Refractrometer, Digital weighing balance/ Spring balance, Magnetic plate with stirrer, pH meter, Conductometer, Flame Photometer, colorimeter and a double distillation plant etc.
- Students and teachers participation in International, National, State and Regional seminars and conferences. Along with Industry aligned academia, expert interaction, is the key features of the department.
- Curricular and the co-curricular activities are well balanced in the Teaching Learning environment to provide holistic education to the students.
- The outcome based teaching model of faculty comprising of theoretical work, regular academic activities such as research projects, seminars, resource learning and hands-on laboratory work.
- Along with Industry aligned academia, expert interaction, is the key features of the department.

MSc. (Hons.) Mathematics

In this degree, candidates get a deeper knowledge of advanced mathematics through a vast preference of subjects such as geometry, calculus, algebra, number theory, dynamical systems, differential equations, etc. The students become more skilled and specialized in a particular subject after the master degree program. In this course, students learn to collect big data and analyse them with the help of different tools and methods.

Vision

To aspire, achieve and sustain for excellence in academics and research through scientific knowledge so as to provide solutions to global environmental issues and transform graduates into responsible citizens and competent professionals.

Mission:

- 1.Holistic development of learner through academic excellence, employability, acquisition of analytical skills and higher research.
- 2.To explore and advance new frontiers in physical sciences and integration with interdisciplinary sciences through visionary research for the benefit of society
- 3.To develop graduates for lifelong learning and professional growth.

ELIGIBILITY CRITERIA : **B.Sc**. (Pass) with **Mathematics** as one of the Core subjects /**B.Sc**. (Hons.) **Mathematics** with 50% marks (45% marks in case of **SC**/ST candidates) in aggregate or equivalent grade from any university recognized by **UGC**.

DURATION: 2 Years

CAREER PATHWAYS

Mathematics offers a huge variety of career opportunities. It is important to plan ahead and know about your options.

The following guide is designed to help you navigate through the maze of career options that exist for maths graduates. Each of the pages below offer an insight into relevant careers for maths graduates, including a description of career, the skills required, the pros and cons, as well as useful links.

Possible career choices:

- Accountancy & Professional Service
- The Actuarial Profession
- Banking - Investment Banking
- Banking - Retail Banking
- Computing & IT
- Engineering Sciences
- General Management

- Operational research
- Postgraduate Study - MSc & Taught Courses
- Postgraduate Study - PhD
- Statistical research
- Teaching

Programme Educational Objective (PEO) (The Course Objective is....)	
PEO1.	To provide high quality education in pure and applied mathematics.
PEO2.	To develop talented and committed human resource which act as catalyst to support interdisciplinary research and become fit for industry and entrepreneur.
PEO3.	To motivate for research in mathematical and statistical sciences.
PEO4.	To empower students to investigate new mathematical methodologies for future applications.
PEO5.	To develop employable skills and life time leaning skills to handly real world challenging problems.
PEO6	To develop employable skills and life time learning .
Programme Outcomes (PO)(At the end of Programme/Degree mentioned above, the post graduates will be able to .....)	
PO1.	**Disciplinary Knowledge:** The student has acquired in-depth knowledge of the various concepts and theoretical principles of Mathematics and is aware of their manifestations. An understanding of the centrality of Mathematics is usually evident from familiarity with interfacial disciplines. A postgraduate in Mathematics is expected to be thoroughly conversant with all fundamental laws and principle in variety of areas of Mathematics along with their applications.
PO2.	**Critical thinking:** Critical thinking as an attribute enables a student to identify, formulate and analyze a complex variety of problems in Mathematics. A postgraduate in Mathematics is expected to assess, reconstruct and solve the problem.
PO3.	**Problem solving:** A vital part of Mathematics curriculum is problem solving. The student will be well-equipped to solve complex problems of Mathematics related to engineering etc that are best approached with critical thinking.
PO4.	**Scientific /Analytical reasoning:** Students learn to investigate, computational/ analytical methods, relate information and interpretation of data based on scientific reasoning. The student will be able to draw logical conclusions based on a group of observations, mathematical techniques and measurements.
PO5.	**Modern tool usage:** Increasing the usage of appropriate techniques, resources having interface with computers and use of computers in laboratory work creates this attribute. A student with degree in Mathematics is able to employ knowledge and skill in computers in a variety of situations- data analysis, coding of complex physics problems as well as information retrieval and library use.
PO6.	**Multicultural Competence:** Development of a set of competencies in order to enhance and promote the growth of multicultural sensitivity with in universities to assess societal, health, safety, legal and cultural issues. Ingrating multicultural

	awareness such as race, gender, physical ability, age, income and other social variables and by creating an environment that is, " welcoming for all students"
PO7.	**Environment & Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8.	**Research related skills & Ethics**: Develop skills for critically review scientific information and become able to comprehend and write effective reports and design documentation. Able to create a sense of ethical responsibilities among students. The student is aware of what constitutes unethical behaviour--plagiarism, fabrication and misrepresentation or manipulation of data.
PO9.	**Self-directed learning:** Students are encouraged to accept challenges in Mathematics by information available to them. Various activities/advanced ideas require the students to find relevant information and educate themselves.
PO10.	**Individual and team work:** Leadership is essential in making teamwork into a reality. Working in teams promotes both teamwork and leadership qualities in the student**.** Teams may comprise of peers in classroom, labs or any other team of members from diverse fields. The student is capable of contributing meaningfully to team ethos and goals.
PO11	**Communication skills:** Effective communication is a much desirable attribute across courses. However, a Mathematics student is expected to assimilate technical information about Mathematics from various sources and convey it to intended audience, both orally and in writing in an intelligible manner.
PO12.	**Lifelong learning:** Having a strong conceptual framework in the subject along with the skills of teamwork, analytical reasoning, problem solving, critical thinking etc. make the students lifelong learners.
Programme Specific Outcomes (PSO) Post graduates will	
PSO1.	Acquired critical analysis and problem solving skills with respect to all field of core mathematics required for science and engineering application.
PSO2.	Attained mathematical knowledge of experimental/computational techniques and instrumentation required to work independently in research or industrial environments.
PSO3.	Become a person with sharpen analytical thinking, logical deductions and rigor in reasoning.
PSO4.	Ability to apply mathematical methodologies to open- ended real -world situations.
PSO5	Acquire ability to explain applications of Mathematics relates to the real world in term of advanced computational/numerical methods, advanced software and analytical tools.

ABOUT THE CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. The basic idea is to look into the needs of the students so as to keep up-to-date with development of higher education in India and abroad. CBCS aims to redefine the curriculum keeping pace with the liberalization and globalization in education. CBCS allows students an easy mode of mobility to various educational institutions spread across the world along with the facility of transfer of credits earned by students.

1. Curriculum Structure: M.Sc (Hons.) Mathematics degree programme will have a curriculum with Syllabi consisting of following type of courses:

I. **Ability Enhancement Courses (AEC):** The Ability Enhancement Courses (AEC) may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). AECC courses are the courses based upon the content that leads to Knowledge enhancement; these are mandatory for all disciplines.

SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

A. Ability Enhancement Compulsory Courses (AECC): Human Values and Professional Ethics, Computer, Environmental Science /Natural Hazards and Disaster management, Communication.

B. Skill Enhancement Courses (SEC): These courses may be chosen from a pool of Courses designed to provide value-based and/or skill-based knowledge.

II. **Core Courses (CR):** A course, which should compulsorily by studied by a candidate as a core requirement is termed as a Core course. These courses are employability enhancement courses relevant to the chosen program of study. Program core comprises of Theory, Practical, Project, Seminar etc. Project work is considered as a special course involving application of knowledge in solving/ analyzing/exploring a real life situation/ difficult problem.

III. **Elective Courses:** Elective course is 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 with provides an extended scope or which enables an

exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill. Accordingly, elective course may be categorizes as:

A. Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.
B. Project (I): An elective course designed to acquire 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/faculty member is called dissertation/project.

2. NOMENCLATURE USED:

A. Postgraduate Core Courses

i. Core Course(CR)
ii. Theory Subject (T)
iii. Practical (P)

B. Ability Enhancement Courses (AEC):

i. Ability Enhancement Compulsory Courses (AECC)
ii. Skill Enhancement Courses (SEC).

C. Elective Courses (EL)

i. Discipline Specific Elective(DSE)

M.Sc.(Hons.) Mathematics

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19.	SEC	MAT627	Seminar	**III**	
20.	EC	MAT*	**Discipline Specific Elective I** (Choose any one) A. MAT613 (Operation Research-I) B. MAT615 (Fluid Mechanics - I) C. MAT617(Topological Vector Spaces) D. MAT629 (Fundamental of Python)	**III**	40-46
21.	EC	MAT*	**Discipline Specific Elective II** Choose any one) A. MAT619 (Differential Geometry) B. MAT621 (Calculus of Several Variables) C. MAT623 (Discrete Mathematics) D.MAT631 (Fractional Calculus)	**III**	47-53
22.	AECC	EVS003	Natural Hazards and Disaster management	**III**	54-55
23.	CR	MAT602	Functional Analysis	**IV**	57-58
24.	CR	MAT604	Number Theory	**IV**	59-60
25.	CR	MAT606	Field Extensions and Galois Theory	**IV**	61-62
26.	EC	MAT*	**Discipline Specific Elective III** (Choose any one) A. MAT616 (Operational Research-II) B. MAT618 (Fluid Mechanics-II) C. MAT620(Special Functions) D. MAT630 (Introduction to R Programming)	**IV**	63-70
27.	EC	MAT*	**Discipline Specific Elective I**V (Choose any one)	**IV**	71-77

			A. MAT622(Advanced Numerical Analysis) B. MAT624(Fuzzy Set Theory) C. MAT626(Advanced Complex Analysis) D. MAT632 (Coding Theory)		
28.	SEC	MAT628	Project (Research Paper review and Viva)	**IV**	

Core Courses

Ability Enhancement Courses

S.No.	Subject Code	Subjects	Semester	Page no.
1.	CSE558	Fundamental of Computer Science-Theory	**II**	25-26
2.	CSE560	Fundamental of Computer Science-Lab	**II**	27-28
3.	SSC006	Human values and professional Ethics	**I**	12-13
4.	EVS003	Natural Hazards and Disaster management	**III**	54-55

Discipline Specific Elective Courses

S.No.	Subject Code	Subjects	Semester	Page no.
1	MAT613 MAT615 MAT617 MAT629	**A.** Operation Research – I **B.** Fluid Mechanics-I **C.** Topological Vector Spaces **D.** Fundamental of Python	**III**	40-46
2	MAT619 MAT621 MAT623 MAT631	**A.** Differential Geometry **B.** Calculus of Several Variables **C.** Discrete Mathematics **D.** Fractional Calculus	**III**	47-53
3	MAT616 MAT618 MAT620 MAT630	**A.** Operation Research-II **B.** Fluid Mechanics –II **C.** Special Functions **D.** Introduction to R Programming	**IV**	63-70
4	MAT622 MAT624 MAT626 MAT632	**A.** Advanced Numerical Analysis **B.** Fuzzy Set Theory **C.** Advanced Complex Analysis **D.** Coding Theory	**IV**	71-77

Skill Enhancement Courses

S.No.	Subject Code	Subjects	Semester
1.	MAT540	Research Methodology & IPR	**II**
2	MAT627	Seminars	**III**
3.	MAT628	Project (Research Paper review and Viva)	**IV**

Scheme for M.Sc. (Hons.) Mathematics

Semester-I

I. Theory Subjects

S. No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	MAT501	Real Analysis-I	5:0:0	5:0:0	5	5
2	CR	MAT503	Complex Analysis	5:0:0	5:0:0	5	5
3	CR	MAT505	Abstract Algebra-I	5:0:0	5:0:0	5	5
4	CR	MAT507	Ordinary Differential Equations	5:0:0	5:0:0	5	5
5	CR	MAT509	Classical Mechanics and Calculus of Variations	5:0:0	5:0:0	5	5
6	AECC	SSC006	Human values and professional Ethics	3:0:0	3:0:0	3	3

Total Credit Hours-28
Total; Contact Hours- 28

CR: Core Course
AEC: Ability Enhancement Course
SEC: Skill Enhancement Course

Scheme for M.Sc.(Hons.) Mathematics

Semester-II

I. Theory Subjects

S. No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	MAT502	Real Analysis-II	5:0:0	5:0:0	5	5
2	CR	MAT504	Abstract Algebra-II	5:0:0	5:0:0	5	5
3	CR	MAT506	Mathematical Methods	5:0:0	5:0:0	5	5
4	CR	MAT508	Partial Differential Equations	5:0:0	5:0:0	5	5
5	CR	MAT510	Linear Algebra	5:0:0	5:0:0	5	5
6	AEC	CSE558	Fundamental of Computer Science-Theory	3:0:0	3:0:0	3	3
7	SEC	MAT540	Research Methodology & IPR	3:0:0	3:0:0	3	3

II. Practical Subject

S.No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	AEC	CSE560	Fundamentals of Computer Science-Lab	0:0:2	0:0:1	2	1

Total Credit Hours-32
Total; Contact Hours- 33

CR: Core Course
AEC: Ability Enhancement Course
SEC: Skill Enhancement Course

Scheme for M.Sc. (Hons.) Mathematics

Semester-III

I. Theory Subjects

Sr. No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	MAT601	Topology	5:0:0	5:0:0	5	5
2	CR	MAT603	Probability and Statistics	5:0:0	5:0:0	5	5
3	CR	MAT605	Numerical Analysis	4:0:0	4:0:0	4	4
4	DSE	MAT613/ MAT615/ MAT617/ MAT629	**Choose Any One:** Operation Research-I/ Fluid Mechanics -I/ Topological Vector Spaces/ Fundamental of Python	4:0:0	4:0:0	4	4
5	DSE	MAT619/ MAT621/ MAT623/ MAT631	**Choose Any One:** Discrete Mathematics/ Differential Geometry/ Calculus of Several Variables/ Fractional Calculus	4:0:0	4:0:0	4	4
6.	AECC	EVS003	**Natural hazards and disaster management**	3.0.0	3:0:0	3	3

II. Practical Subjects

Sr. No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	MAT625	Numerical Analysis Lab	0:0:4	0:0:2	4	2
2	SEC	MAT627	Seminar	0:0:2	0:0:1	2	1

Total Credit Hours-28
Total; Contact Hours- 31

CC: Core Course
EC: Elective Course
SEC: Skill Enhancement Course

Scheme for M.Sc. (Hons.) Mathematics

Semester-IV

I. Theory Subjects

Sr. No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	MAT602	Functional Analysis	5:0:0	5:0:0	5	5
2	CR	MAT604	Number Theory	5:0:0	5:0:0	5	5
3	CR	MAT606	Field Extensions and Galois Theory	5:0:0	5:0:0	5	5
4	DSE	MAT616/ MAT618/ MAT620/ MAT630	**Choose Any One:** Operational Research-II/ Fluid Mechanics-II/ Special functions / Introduction to R Programming	4:0:0	4:0:0	4	4
5	DSE	MAT622/ MAT624/ MAT626/ MAT632	**Choose Any One:** Advanced Numerical Analysis/ Fuzzy Set Theory/ Advanced Complex Analysis/ Coding Theory	4:0:0	4:0:0	4	4

II. Practical Subjects

Sr. No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	SEC	MAT628	Project (Research Paper review and Viva)	0:0:8	0:0:4	8	4

Total Credit Hours-27
Total; Contact Hours- 31

CR: Core Course
EC: Elective Course
SECC: Skill Enhancement Course

Summarized Report of Course Scheme for M.Sc.(Hons) Mathematics

SEM	L	T	P	Contact hrs/week	Credits hrs/week	Credits hrs/week			
						CR	AEC	SEC	DSE
I	25	0	0	28	28	25	3	0	0
II	30	0	2	33	32	25	4	3	0
III	22	0	6	31	28	16	3	1	8
IV	23	0	8	31	27	15	0	4	8
Total	100	0	16	123	115	81	10	8	16

SEMESTER I

Course Code	**MAT501**
Course Title	**Real Analysis-I**
Type of course	Core
L T P	50 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	The aim of this course is to learn fundamental concepts of metric spaces, the Riemann-Stieltjes integral as a generalization of Riemann Integral, the calculus of several variables and basic theorem.
Course Outcomes (CO)	After the completion of the course, students will be able to: 1. describe fundamental properties of the real numbers that lead to the formal development of real analysis. 2. comprehend rigorous arguments developing the theory underpinning real analysis. 3. demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.

UNIT-I

Finite, Countable and Uncountable sets, Metric spaces: definition, open sets, closed sets, interior and exterior point, adherent point,Compact sets, Heine-Borel Theorem, Perfect sets, The Cantor set, Separated sets, connected sets, Connected subsets of real line, Disconnected sets, Components.

UNIT-II

Limits of functions, Continuous functions, Compactness, Connectedness, monotonic functions, Infinite limits and Limits at infinity.

UNIT-III

Definition and existence of the Riemann-Stieltjes integral, Properties of the integral, Integration and differentiation, Fundamental Theorem of Calculus, Mean Value Theorems of Riemann Stieltje's integral.

UNIT-IV

Convergent sequences, Sub sequences, Cauchy sequences, Complete metric spaces, Cantor's Intersection Theorem, Baire's Category Theorem, Banach contraction principle, Functions of bounded variation.

Text & Reference Books:-

S. No.	**Name**	**Author(S)**	**Publisher**
1	Principles of Mathematical Analysis	Walter Rudin	McGraw-Hill Ltd

2	A course of Mathematical Analysis	Shanti Narayan	S.Chand
3	Mathematical Analysis	S.C.Malik	Wiley Eastern
4	Introduction to Real Analysis	R. G. Bartle	John Wiley and Sons
5	Elements of Real Analysis	H. S. Gaskill and P. P.Narayanaswami	Printice Hall,
6	Real Analysis	H.L. Royden	Macmillan *Company* Collier-*Macmillan* Limited

Course Code	**MAT503**
Course Title	**Complex Analysis**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	The objective of this course is to introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of the fundamental concepts of Complex Analysis such as analytic functions, complex integrals and a range of skills which will allow students to work effectively with the concepts.
Course Outcomes (CO)	At the end of this course, students will be able to : 1. demonstrate the remarkable properties of complex variable functions, which are not the features of their real analogues. 2. acquire knowledge about different types of functions viz. analytic, entire and meromorphic functions occur in complex analysis along with their properties. 3. apply the knowledge of complex analysis in diverse fields related to mathematics. 4. utilize the concepts of complex analysis to specific research problems in mathematics or other fields. 5. enhance and develop the ability of using the language of mathematics in analyzing the real-world problems of sciences and engineering.

UNIT-I

Complex plane, Stereographic projection, Riemann sphere, Function of complex variables, Continuity and Differentiability, Analytic functions, Conjugate function, Harmonic function, Cauchy Riemann equations (Cartesian and Polar form), Construction of analytic functions. Branch cut and Branch point.

UNIT-II

Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form. Cauchy's inequality, Poisson's integral formula, Morera's theorem,Liouville's theorem, conformal transformation, Bilinear transformation, critical points, fixed points, Cross ratio problems.

UNIT-III

Meromorphic and entire function, Power series, Taylor's theorem, Laurent's theorem, Maximum modulus theorem (Principle), Schwarz's Lemma, poles and zeroes of meromorphic functions, Argument principle, and Fundamental theorem of Algebra and Rouche's theorem.

UNIT-IV

Zeros, Singularities, Residue at a pole and at infinity, Cauchy's Residue theorem, Jordan's lemma, Integration round unit circle, Evaluation of Integrals of the type $\int f(z)dz$where $f(z)$is a rational function with degree of denominator polynomial greater than that of numerator polynomial by at least two and $C$is a circle, $\int_0^{2\pi} f(sin\theta, cos\theta)d\theta$ and$\int_{-\infty}^{\infty} f(x)dx$.

Text & Reference books:-

S. No	Name	Author(S)	Publisher
1	Complex Analysis	J.V Deshpande	Tata McGraw-Hill Publishing Company
2	Complex Analysis, third edition (International student edition)	D.V Ahlfors	McGraw-Hill International Book Company.
3	An Introduction to the theory of functions of a Complex Variable	E.T Copson	The English Language Book Society and Oxford University Press.
4	Functions of Complex Variable and Application	James ward Brown,Ruel V. Churchill	McGraw Hill Higher Education
5	Complex Variables	M. R. Spiegel	McGraw Hill Book Company
6	Complex Variables and Applications	J. W. Brown, R. V. Churchill.	McGraw Hill,

Course Code	**MAT505**
Course Title	**Abstract Algebra-I**
Type of course	Core
L T P	500
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	This course covers some advanced topics of Group Theory and basic concept of ring theory, which are two most important branches of algebra.
Course Outcomes(CO)	Students will be able to: 1. demonstrate insight into abstract algebra with focus on axiomatic theories. 2. demonstrate knowlegde and understanding of fundamental concepts including groups, subgroups, normal subgroups, homomorphisms and isomorphism. 3. demonstrate knowlegde and understanding of rings, fields and their properties.

UNIT-I

Review of basic property of Groups: Subgroups and cosets, cyclic groups, normal subgroups and quotient groups. Permutation groups, Even and odd permutations, Conjugacy classes of permutations, Alternating groups, Simplicity of An, n > 4. Cayley's Theorem, Direct productsof groups.

UNIT-II

Fundamental Theorem for finite abelian groups, Sylow theorems and their applications, Finite Simple groups, Groups of order p^2 pq (p and q primes).

UNIT-III

Solvable groups, Normal and subnormal series, composition series, the theorems of Schreier and Jordan Holder

UNIT-IV

Review of rings and homomorphism of rings, Ideals, Algebra of Ideals, Maximal and prime ideals, Ideal in Quotient rings, Field of Quotients of integral Domain, Matrix Rings and their ideals, Rings of Endomorphisms of Abelian Groups.

Text & Reference books:-

S. No	Name	Author(S)	Publisher
1	Schaum's outline of modern	Frank Ayres	Schaum's outline series

	abstract algebra		
2	Basic Abstract Algebra	P.B. Bhattacharya, S.K. Jain& S.R. Nagpaul	Cambridge University Press
3	A Course in Abstract Algebra	Vijay K Khanna and S K Bhambri	Vikas Publishing house
4	Contemporary Abstract Algebra,	J. A. Gallian	NarosaPublisihng House,
5	A First Course in Abstract Algebra	J. B. Fraleigh	Addison-WeseleyPublising
6	The Theory of Groups	J. Rotman	Allyn and Bacon, London,

Course Code	**MAT507**
Course Title	**Ordinary Differential Equations**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	The objective of the course is to equip the students with fundamental knowledge and problem solving skills in power series solutions of ODE, existence and uniqueness theory of initial value problems and solution of systems of differential equations.
Course Outcomes(CO)	Students will be able to: 1. explain the concept of differential equation. 2. solve higher order differential equations and exact equations. 3. Expresses the basic existence theorem for higher- order linear differential equations.

UNIT-I

Review of fundamentals of Ordinary differential equations. The method of successive approximation.Initial value problem, Ascoli's Lemma, Gronwall's inequality, Cauchy Peano Existence Theorem, Picard's existence and uniqueness theorem, Lipschitz condition.

UNIT-II

Linear system of equations (homogeneous & non homogeneous). Superposition principle, Fundamental set of solutions, Fundamental Matrix, Wronskian, Abel Liouville formula, Reduction of order, Adjoint systems and Self Adjoint systems of second order. Linear 2nd order equations, preliminaries, Sturm's separation theorem, Sturm's fundamental comparison theorem.

UNIT-III

Orthogonal set of functions, Orthonormal set of functions, Gram-Schmidth process of orthonormalization, Sturm Liouville's boundary value problems, Orthogonality of Eigenfunctions and reality of Eigenvalues. Adjoint forms, Lagrange identity, Green function to solve boundary value problems.

UNIT-IV

Power series solution of differential equation about an ordinary point, Solution about regular singular points: The method of Frobenius, Applications, Legendre's, Hermite's and Bessel's equation. Ordinary differential equations in more than two variables: Simultaneous Differential equations of the first order and the first degree in three variables, Methods of their solution and applications.

Text & Reference books:-

S. No	Name	Author(S)	Publisher
1	Differential Equations	Piaggio	CBS Publisher
2	Differential Equations	S.L. Ross	John Wiley and Sons
3	Introduction to Ordinary Differential Equations.	E.A. Coddington	Prentice-Hall of India Private Ltd
4	Elements of Partial Differential Equations.	I. N. Sneddon	Tata McGraw Hill
5	Ordinary Differential Equations: Theory and Applications	M. Rama MohanaRao	East-West Press Pvt. Ltd
6	Advanced Differential Equations	M.D.Raisinghania	S.Chand&CompanyLtd.

Course Code	**MAT509**
Course Title	**Classical Mechanics and Calculus of Variations**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	To introduce the concept of variation of functionals and variational techniques. Dynamics of rigid bodies, Lagrangian and Hamiltonian equations for dynamical systems are also introduced at large.
Course Outcomes(CO)	After the completion of the course the students will be able to: 1. solve isoperimetric problems of standard type. 2. solve simple initial and boundary value problems by using several variable calculus. 3. solve mechanics problems in one dimension that involve one or more of the forces of gravity, friction and air resistance.

UNIT-I

The variation of a functional and its properties, Fundamental lemma of calculus of variations, Euler's equation for one dependent function and its different forms, Motivational problems of calculus of variation- Shortest distance in a plane, Minimum surface of revolution, Brachistochrone problem, Geodesics, Isoperimetric problems, Functionals involving several dependent variables, Functionals involving higher order derivatives.

UNIT-II

Variational problems with moving boundaries, Approximate solutions of Boundary Value Problems- Rayleigh-Ritz method, Galerkin's method, Generalised coordinates, Degree of freedom, Constraints, Holonomic and non-holonomic systems, Generalised velocity, Generalised potential, Generalised force, principle of virtual work, D'Alembert's principle, Lagrange's Equation, Simple applications of the Lagrangian formulation.

UNIT-III

Hamiltonian principle, principle of least action, derivation of Lagrange's equations from Hamilton's principle, Legendre transformations, Hamilton's canonical equation of motion, Solving problems using Hamilton's equations, Cyclic co-ordinates, Conservation theorems, Routhian.

UNIT-IV

Central force, Equivalent one-body problem, Motion in a central force field, Moments and product of inertia, Theorems of Parallel and Perpendicular axes, Angular momentum of a rigid

body about a fixed point and about fixed principal axes, Euler's dynamical equations for motion of rigid body.

Text & Reference Books:-

S. No	Name	Author(S)	Publisher
1	Text Book of Dynamics	F. Chorlton	CBS Publishers, New Delhi.
2	Dynamics of rigid body	S.L. Loney	New Age International Private Limited
3	Classical Mechanics	D.E Rutherford,	Oliver & Boyd Ltd.
4	An Introduction to the Calculus of Variation	C. Fox	York: Dover Publications, 1987
5	Differential Equations and the Calculus of Variations	Elsgolts, L.	University Press of the Pacific, 2003.

Course Code	**SSC006**
Course Title	**Human values& Professional Ethics**
Type of Course	ID
L T P	3:0:0
Credits	3
Course Prerequisites	None
Course Objectives (CO)	To help the students to discriminate between valuable and superficial in the life. To help students develop sensitivity and awareness; leading to commitment and courage to act on their own belief. This Course will encourage the students to discover what they consider valuable. Accordingly, they should be able to discriminate between valuable and the superficial in real situations in their life. This course is an effort to fulfill our responsibility to provide our students significant input about understanding.
Course Outcome	1. Students will behave ethically and promote human values in society. 2. Students will behave professionally.

UNIT-I:Course Introduction-Need, Basic Guidelines, Content and Process for Value Education : Understanding the need, basic guidelines, content and process for Value Education, Understanding Happiness and Prosperity correctly.
Understanding Harmony in the Human Being : Understanding the harmony with self and the Body: Sanyam and Swasthya.

UNIT II:Harmony in Human Relationship: Understanding harmony in the Family- the basic unit of human interaction, visualizing a universal harmonious order in society **Understanding Harmony in the Nature and Existence:** Understanding the harmony in the Nature, Holistic perception of harmony at all levels of existence

UNIT III: Understanding of Harmony on Professional Ethics: Ability to utilize the professional competence for augmenting universal human order, Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems
.
UNIT IV:Strategy for transition from the present state to Universal Human Order: At the level of individual, at the level of society. **Case studies**: typical holistic technologies, management models and production systems

Recommended Books

S. No.	Author(S)	Year	Publisher
1	A Foundation Course in Value Education	R R Gaur, R Sangal	Excel Books Publishers
2	Energy & Equity	Ivan Illich	.The Trinity Press, Worcester, and HarperCollins, USA
3	Human Values and Professional Ethics	RishabhAnand	Satya Prakashan, New Delhi
4	Jeevan VidyaekParichay.	A Nagraj	Divya Path Sansthan,Amarkantak.

SEMESTER II

Course Code	**MAT502**
Course Title	**Real Analysis-II**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	The objective of this course is to study the convergence of sequences and measure in an abstract setting after having studied Lebesgue measure on real line. The general $\mathbf{L^P}$spaces are also studied.
Course Outcomes(CO)	At the end of this course, students will be able to: 1. Improve and outline the logical thinking. 2. Illustrate how to communicating with: Peers, Lecturers and Community 3. Define and recognize the basic properties of the field of real number

UNIT-I

Cluster Point, Definition of point-wise and uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence, nowhere differentiable functions, Weierstrass's non-differentiable function, Weierstrass Approximation Theorem, Stone-Weierstrass's Theorem.

UNIT-II

Lebesgue and Outer Measure, Properties of Measurable Sets and Non Measurable Sets, σ-Algebra, Boral sets.

UNIT-III

Definition & Properties of Measurable functions, Characteristic functions, Step Functions and Simple Functions, Egoroff's Theorem, Lusin Theorem, Little wood's three Principles, Signed measures, The Lp-spaces, Riesz-Fischer Theorem; Riesz Representation theorem for Lp spaces, Radon-Nikodym theorem, Dual of Lp-spaces,The extension theorem.

UNIT-IV

Lebesgue Integral of bounded function, Comparison of Riemann and Lebesgue Integral, Integral of a non negative function, Convergence in measure, Bounded Convergence Theorem, The general Lebesgue integral. Differentiation and Integration: Differentiation of monotone functions, Fatou's Lemma, Monotone Convergence Theorem and Differentiation of an integral, Absolute Continuity.

Text & Reference books:-

S. No	Name	Author(S)	Publisher
1	Principles of Mathematical Analysis (3rd Edition)	Walter Rudin	McGraw-Hill Ltd
2	Mathematical Analysis	S.C.Malik	Wiley Eastern
3	Introduction to Real Analysis	R. G. Bartle	John Wiley and Sons
4	Elements of Real Analysis	H.Gaskill andNarayanaswami	Printice Hall,
5	Real Analysis	H.L. Royden,	Macmillan Co.
6	Mathematical Analysis,	T. Apostol	Narosa Publishers
7	Elementary Analysis: The Theory of Calculus	K. Ross	Springer Int. Edition

Course Code	**MAT504**
Course Title	**Abstract Algebra-II**
Type of course	Core
L T P	500
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	The objective of this course is to introduce the advanced concepts of ring theory and modules.
Course Outcomes(CO)	After the completion of the course, the students will be able to : 1. recognise technical terms and appreciate some of the uses of algebra 2. Simplify & Elaborate some formulas of Abstract Algebra 3. solve simple linear equations

UNIT-I

Rings:-Factorization Theory in Integral Domains, Divisibility, Unique Factorization Domain, Principal Ideal Domain , Euclidian Domain and their relationships, Polynomial rings over UFD's, Gauss's Lemma, Reducible and irreducible polynomials.

UNIT-II

Noetherian and Artinian Rings, Examples and Counter Examples, Artinian Rings without zero divisors, Nil Ideals in Artinian Rings, Hilbert Basis Theorem.

UNIT-III

Modules, submodules, free modules, quotient modules, Homomorphism theorems, direct sums, finitely generated modules, Simple modules, cyclic modules, differences between modules over rings and vector spaces.

UNIT-IV

Modules over PID's, structure theorem of modules over PID's, Torsion modules, Torsion free modules, Artinian and Noetherian Modules, Artinian And Noetherian rings, modules of finite length.

Text & Reference books:-

S. No	**Name**	**Author(S)**	**Publisher**
1	Topics in Algebra	I. N. Herstein,	Xerox Publishing Company Mass
2	Schaum's outline of modern abstract algebra	Frank Ayres	Schaum's outline series

3	Basic Abstract Algebra,	P.B. Bhattacharya, S.K. Jain, & S.R. Nagpaul	Cambridge University Press
4	A Course in Abstract Algebra	Vijay K Khanna and S. K. Bhambri	Vikas Publishing house
5	Contemporary Abstract Algebra,	J. A. Gallian	NarosaPublisihng

Course Code	**MAT506**
Course Title	**Mathematical Methods**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	To acquaint the students with the application of Laplace, Fourier transform and integral equations.
Course Outcomes(CO)	At the end of this course, students will be able to: 1. Solve problems using mathematics in unfamiliar settings. 2. engage in analyzing, solving, and computing real-world applications. 3. use mathematical concept while solving various problems of Engineering.

UNIT-I

Laplace Transform: Definition, existence and basic properties of the Laplace transform, Inverse Laplace transform, Convolution theorem, Laplace Transform solution of linear differential equation and simultaneous linear differential equation with constant coefficients, Complex inversion formula.

UNIT-II

Fourier Transform: Definition, existence and basic properties, Inversion formula of Fourier transform Convolution theorem, Parseval's relation. Fourier transform of derivatives and integrals, Fourier sine and cosine transform, Inverse Fourier transform, Solution of linear ordinary differential equations and partial differential equations.

UNIT-III

Linear integral equations, Special types of kernels, Singular integrals equations, Connection of integral equations with differential equations, Integral equations of the convolution type.

UNIT-IV

Solution of Fredholm Equations with iterated kernel, Fredholm Equations with general kernel: Solution by the method of successive approximations, adomian decomposition method, Volterraintegral equations: Solution by the method of successive approximations, adomian decomposition method.

Text & Reference Books

S. No	Name	Author(S)	Publisher
1	Integral Equations	B.L. Moiseiwitsch	Pitman press, Bath Ltd.
2	Fourier series and Integral Transform	A. Pinckusand S. Zafrany.	Cambridge University Press
3	The Classical Theory of Integral Equations: A Concise Treatment.	S. M. Zemyan	New York: Birkhäuser
4	A First Course in Integral Equations.	A.M. Wazwaz	World Scientific

Course Code	**MAT508**
Course Title	**Partial Differential Equations**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with mathematics
Course Objective (CO)	The objective of this course is to introduce the concepts of partial differential equations. To develop analytical techniques to solve partial differential equations. To understand the properties of solution of partial differential equations
Course Outcomes(CO)	At the end of the course, the students will be able to: 1. solve the systems of linear differential equations. 2. solve the homogeneous linear systems with constant coefficients. 3. find the type of a linear differential equation systems.

UNIT-I

First Order linear and quasi Partial differential equations, method of Lagrange's, Integral surface through a given curve, Surface orthogonal to given system of surfaces. Nonlinear Partial differential equations of first order, Charpit's Method and Jacobi's Method, Cauchy problem for first order PDE's.

UNIT-II

Partial Differential Equations of Second and Higher Order: Origin of second order partial differential equations. Higher order partial differential equations with constant coefficients. Equations with variable coefficients.Classification of second order partial differential equations. Canonical forms. Solution of non-linear second order partial differential equations by Monge's method.

UNIT-III

Method of Solution: Separation of variables in a PDE; Laplace, wave and diffusion equations, Elementary solutions of Laplace equations.

UNIT-IV

Applications of PDE: Wave equation, the occurrence of wave equations, elementary solutions of one dimensional wave equation; vibrating membranes, three dimensional problems. Diffusion equation, resolution of boundary value problems for diffusion equation, elementary solutions of diffusion equation.

Text &Reference books:-

S. No	Name	Author(S)	Publisher
1	Elements of Partial Differential Equations.	I.N. Sneddon, I. N.	Tata McGraw Hill
2	Differential Equations.	Piaggio	CBS Publisher
3	Differential Equations.	S.L. Ross	John wiley and Sons
4	Introduction to Ordinary Differential Equations.	E. A. Coddington	McGraw-Hil
5	Advanced Differential Equations	M.D. Raisinghania	S. Chand & Company

Course Code	**MAT510**
Course Title	**Linear Algebra**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.sc with Mathematics and B.A with Mathematics
Course Objective (CO)	The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines. The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences.
Course Outcomes (CO)	Students will be able to: 1. understand the concept of basis and dimensions of vector space and solve the system of linear equations. 2. use the concept of the Eigen values and Eigenvectors, Characteristic and minimal polynomials, Canonical forms, Diagonal forms, triangular forms, Rational and Canonical Jordan Forms. 3. solve the numericals based on Inner Product Spaces, Norms and Distances, Orthonormal basis, The Gram-Schmidt orthogonalization, Normal and self-adjoint Operators 4. apply the concept of Unitary and Normal Operators, Spectral Theorem, Bilinear and Quadratic forms in the applied fileds of mathematics 5. Apply the knowledge of Linear Algebra to attain a good mathematical maturity and enables to build mathematical thinking and skill.

UNIT-I

Vector Spaces, Subspaces, Linear dependence, Basis and Dimensions, Algebra of Linear Transformation, Algebra of Matrices, Row rank, Column rank and their equality, System of Linear Equations.

UNIT-II

Eigen values and Eigenvectors, Characteristic and minimal polynomials, companion matrix, Cayley Hamilton Theorem, Matrix representation of Linear Transformation, Change of Basis, Canonical forms, Diagonal forms, triangular forms, Rational and Canonical Jordan Forms.

UNIT-III

Eigen spaces and similarity, Linear functional, Dual Spaces and dual basis, the double dual, Inner Product Spaces, Norms and Distances, Orthonormal basis, The Gram-Schmidt Orthogonalization, Orthogonal complements.

UNIT-IV

The adjoint of a Linear operator on an inner product space, Normal and self-adjoint Operators, Unitary and Normal Operators, Spectral Theorem, Bilinear and Quadratic forms.

Text & Reference books:-

S. No.	Name	Author(S)	Publisher
1	Linear Algebra, 3rd Edition	S. Lipschutz and M. Lipso	Tata McGraw Hill
2	Linear algebra, 2nd Edition	K. Hoffman and R. Kunze	Prentice Hall
3	Undergraduate Texts in Mathematics, 3rd Edition.	S. Lang	New York: SpringerVerlag
4	Linear Algebra Done Right, 2nd Edition.	S. Axler	Springer Verlag

Course Code	**CSE558**
Course Title	**Fundamentals of Computer Science-Theory**
Type of course	Ability Enhancement Course
L T P	3 0 0
Credits	3
Course prerequisite	B.sc with Mathematics and B.A with Mathematics
Course Objective (CO)	To provide the excellent training/knowledge in basic computer science,Operating System,DBMS,SQL,C++.
Course Outcomes(CO)	Students will be able to: 1. Be exposed to basic hardware and software concepts. 2. Be familiar with using C++ functions and the concepts related to good modular design. 3. Be familiar with using C++ structures, pointers and reference parameters.

UNIT- I

Introduction to Computer System:Block diagram of a Computer System and its working, Hardware - CPU, Memory, Input, Output & Storage devices, Software - System &Application,introduction to word processors, creating, editing, printing and saving documents, spell check, mail merge, creating power point presentations, creating spreadsheets and simple graphs,introduction to MS-EXCEL and its features,Internet and its applications.

UNIT-II

Introduction to Operating System: Operating Systems functions, Types of operating systems, Multiprogramming systems, Batch systems, Time-sharing systems, Operating system operations, distributed system.Development Tools: Editors, Translators - Compilers, Interpreters, Linkers Loaders, Debuggers.

UNIT-III

Introduction to Databases: Introduction to database system, purpose of database system, view of data, relational databases, database architecture, Constraint, View and SQL:Introduction to SQL, Features, Data Types, Database Languages, Introduction to view, Integrity constraints and their types.

UNIT-IV

Programming using C++: program design tools–algorithms, flow charts, pseudocode, Decision table,introduction to C++, structure of C++ , basic terminology- Character set, tokens, identifiers,

keywords, fundamental data types, literal and symbolic constants,declaring variables,initializingvariables,typemodifiers,Operators and expressions in C++,Control Statements: if, nested if, if - else. Else if ladder, switch,Loops and iteration: while loop, for loop, do - while loop, nesting of loops, Break statement, continue statement, goto statement,

Text & Reference books:-

S.No.	Name	Author(s)	Publisher
1	A Text Book on Windows Based Computer Courses	Gurvinder Singh &Rachhpal Singh	Kalyani Publishers
2	Introduction to Computers	Norton, Peter	McGraw Hill
3	C++ Programming	Satish Jain	BPB Publications
4	Operating Systems:A Modern Perspective	G. Nutt	Pearson Education
5	Fundamentals of Database Systems, Third Edition	Elmasri/Navathe	Addison Wesley

Course Code	**CSE560**
Course Title	**Fundamentals of Computer Science-Lab**
Type of course	Ability Enhancement Course
L T P	0 0 2
Credits	2
Course prerequisite	B.Sc with Mathematics and B.A with Mathematics
Course Objective (CO)	To provide the practical training/knowledge in basic computer science, Operating System, DBMS, SQL, C++.
Course Outcomes(CO)	Students will be able to: 1. Be able to work with basic features of MS excel. 2. To display documents using various views. 3. Be able to work with the basic features of Word.

4. Wi Familiarization of the computer system and on hand practice on power on and power off window Closing, Maximizing, Icon shifting & Ordering. Practice with Control Panel and File manager.
5. Practice with MS Word. Opening and Closing document. Preparation and setting of a document. Familiarization with various tools, mail-mearge practice.
6. Practice with Power Point and MS Excel sheets
7. **C++ PROGRAMS:**

1. WAP to find the sum of two numbers.
2. WAP to print a string on the screen.
3. WAP to find the simple interest.
4. WAP to find to find the greatest of two numbers.
5. WAP to find P by using P=(W-X)/(Y-Z)
6. WAP to convert temp from Celsius to Fahrenheit.
7. WAP to convert days into years, weeks, days.
8. WAP to display table of given number
9. WAP to find the Arithmetic operations on two numbers.
10. WAP which finds the square root of a number.
11. WAP which use the if statement.
12. WAP which using the if-else statement.
13. WAP which describes the functionality of switch statement.
14. WAP which uses the conditional ternary operator.
15. WAP which uses the for loop.
16. WAP which describes the functionality of While loop.
17. WAP which describes the functionality of Do-While loop.
18. WAP which having the functionality of jumping statements(go to, break,continue).

19. WAP to find the sum of the digits of a number.

Text & References Books

S. No.	Name	Author(s)	Publisher
1	A Text Book on Windows Based Computer Courses	Gurvinder Singh &Rachhpal Singh	Kalyani Publishers
2	C++ Programming	Satish Jain	BPB Publications
3	SQL,PL/SQL,The programming language of oracle	Ivan Bayross	BPB Publication

Course Code	**MAT540**
Course Title	**Research Methodology & IPR**
Type of course	Skill Enhancement Course
L T P	3 0 0
Credits	3
Course prerequisite	B. Sc. Medical or Non-medical or B.A with Mathematics
Course Objective	To acquaint the students about the different types of property rights that a person possesses.
Course Outcomes(CO)	Identify a research problem.
	Understand importance of educational research, interpret the results and report writing.
	Describe the role of Intellectual Property Rights (IPR) in research and development.
	Understand the different types and laws of Intellectual Property Rights (IPR).

UNIT I

Motivation and objectives – Research methods vs. Methodology. Types of research, Research process; criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review development of working hypothesis.

UNIT II

Meaning of research design; need for research design; important concepts related to research design; different research designs. Writing research proposal: Characteristics of a proposal; content and organization of a proposal.

Methods and techniques of data collection- Types of data, Methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study), Methods of secondary data collection (internal/ external), schedule method.

UNIT III

Interpretation and report writing: Meaning of interpretation; technique of interpretation; precautions in interpretation; significance of report writing; layout of research report; types of reports; Presentation of research work-oral, poster and writing research paper; Precautions for writing research report, Computer and its role in research.

UNIT IV

Research Ethics; Role of Intellectual Property Rights (IPR) in Research and development - intellectual property rights and patent law, copy right. Scholarly publishing- IMRAD concept

and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Research Methodology: Methods & Techniques (Rev. Ed.)	C.R. Kothari	New Age International. New Delhi
2	An Introduction to Research Methodology	B.L. Garg, R. Karadia, R., F. Agarwal, F. and U.K. Agarwal	RBSA Publishers
3	Qualitative Inquiry and Research Design: Choosing Among Five Approaches	John W. Creswell	SAGE Publication
4	Principles of Intellectual Property	N.S. Gopalakrishnan, and T.G. Agitha	Eastern Book Company
5	Law relating to patents, trade marks, copyright designs and geographical indications	B.L.Wadehra	Universal Law Publishing
6	An Introduction to Intellectual Property Rights	Venkataraman M	Affliated East-West Press

SEMESTER III

Course Code	**MAT601**
Course Title	**Topology**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc with Mathematics or B.A with Mathematics
Course Objective (CO)	This course aims to teach the fundamentals of point set topology and constitute an awareness of need for the topology in Mathematics.
Course Outcomes(CO)	Students will be able to: CO1: Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics. CO2: Prove basic results about completeness, compactness, connectedness and convergence within these structures. CO3: Demonstrate an understanding of the concepts of Hausdroff spaces.

UNIT-I

Topological Spaces, Examples of topological spaces**:** the product topology, the metric topology, the quotient topology Topological Spaces, Basic concept, closure, interior, exterior and boundary of set, dense set,Closure operator and interior operator. Neighborhoods and neighborhood system.

UNIT-II

Bases for a topology, the subspace topology, Open sets, closed sets and limit points, closures, interiors, continuous functions, homeomorphisms.

UNIT-III

Separated sets, Connected sets, Connected and disconnected spaces, Connectedness on real line,locally connected space, Totally disconnected space, Compact space of the real line, limit point compactness, Heine-Borel Theorem, Local –compactness.

UNIT-IV

The Separation Axioms: The countability axiomsT_0, T_1, and T_2 spaces, examples and basic properties, Hausdorff spaces, Regularity, Complete Regularity, Normal Spaces, Normality, the Urysohn Lemma, the Urysohn Metrization Theorem, the Tietze Extension Theorem, the Tychonoff Theorem.

Text & Reference Books:

S. No	Name	Author(S)	Publisher
1	Elementary general Topology	T.O. Moore	Prentice-Hall
2	Topology	J.R. Munkres	Prentice-Hall
3	Introduction to Topology and Modern Analysis	G.F.Simmons	Tata McGraw-Hill Edition

Course Code	**MAT603**
Course Title	**Probability and Statistics**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.sc with Mathematics and B.A with Mathematics
Course Objective (CO)	The course is designed to equip the students with various probability distributions and to develop greater skills and understanding of Sampling and Estimation.
Course Outcomes(CO)	Students will be able to: 1. learn basic probability axioms, rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables. 2. derive the distribution of function of random variables, 3. how to derive the marginal and conditional distributions of random variables. 4 find the point and interval estimates, derive confidence intervals and understand the methods of estimation 5. analyse data statistically and interpretation of the results.

UNIT-I

Random Variables and Distribution Functions: Discrete and continuous random variables, Probability mass, Probability density and cumulative distribution functions, Joint, marginal and conditional distributions, Mathematical expectation, Variance and moments and Moment generating function.

UNIT-II

Discrete probability distributions: Bernoulli, Binomial, Poisson, Geometric and Negative Binomial distributions and their properties. Continuous probability distributions: Uniform, normal, beta distribution of first and second kind, gamma, exponential distributions and their properties.

UNIT-III

Sampling Theory: Types of Sampling- Simple, Stratified, Systematic, Errors in sampling, Parameter and Statistics. Estimation: Unbiasedness, Consistency, Invariant Estimator, Efficient Estimator, Minimum Variance Unbiased Estimators, Characteristics of Estimators, the Method of Maximum Likelihood Estimation,, properties of estimators, confidence intervals. Exact

Sampling Distributions: Chi-square distribution, Student's-t distribution, Snedecor's F-distribution, Fisher's – Z distribution.

UNIT-IV

Hypothesis Testing*:* Tests of significance for small samples, Null and Alternative hypothesis, Critical region and level of significance, Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Tests of significance based on t, Z and F distributions, Chi square test of goodness of fit. Large Sample tests, Sampling of attributes, Tests of significance for single Proportion and for difference of proportions, Sampling of variables, tests of significance for single mean and for difference of means and for difference of standard deviations.

Text & Reference Books

S.No.	Name	Author(S)	Publisher
1	Introduction to Mathematical Statistics	Hogg Robert V., JoesephMcKlean, and Allen T Craig	Pearson Education Limited
2	Introductory Probability and Statistical Applications	P. L. Meyer	Philippines: Addison-Wesley Publishing Company
3	Fundamentals of Mathematical Statistics	S. C. Guptaand V. K. Kapoor	Sultan Chand & Sons: New Delhi
4	Introduction to Probability and Statistics	J.S. Milton and J.C. Arnold,	Fourth Edition, McGraw Hill
5	An outline of statistical theory (Vol. 1 & 2).	A.M. Goon,M.K. Gupta, & B. Dasgupta	World Press Pvt Limited

Course Code	**MAT605**
Course Title	**Numerical Analysis**
Type of course	Core
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	To familiarize the students about different numerical techniques e.g. solving algebraic and transcendental equations, large linear system of equations, differential equations, approximating functions by polynomials upto a given desired accuracy.
Course Outcomes(CO)	After the completion of the course, the students will be able to: CO1: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems. CO2: Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration. CO3: Solve linear and nonlinear equations, and the solution of differential equations.equations, and the solution of differential equations.

UNIT-I

Errors, Error propagation, Order of approximation. Solution of non-linear equations: Bisection, Regula-falsi, Secant, Newton-Raphson, Generalized Newton's method, Chebyshev method, Halley's methods, General iteration method, Muller's method. Rate of convergence.Newton's method for complex roots and multiple roots, Simultaneous non-linear equations by Newton-Raphson method.

UNIT-II

Operators: Forward, Backward and Shift (Definitions and some relations among them). Interpolation: Finite differences, divided differences, Newton's formulae for interpolation, Lagrange and Hermite interpolation, Cubic Spline interpolation. Numerical integration-Trapezoidal, Simpson's 1/3rd rule, Simpson's 3/8th rule, Boole's rule, Weddle's rule, Errors in Integration formulae.

UNIT-III

Curve fitting: Linear and non-linear curve fitting, curve fitting by sum of exponentials, fitting of exponential Solution of Linear system of equations: Matrix inversion, Gauss-elimination and Gauss-Jordan method, LU decomposition method, Gauss Jacobi and Gauss Seidal method.

UNIT-IV

Solution of differential equations: Taylor series method, Euler's method, Modified Euler's method, Runge - Kutta methods of order two, three and four, Predictor –Corrector methods, Finite Difference Method for ODE and PDE (Boundary value problem).

Text & Reference Books:-

S. No	Name	Author(S)	Publisher
1	Introductory methods of Numerical Analysis	S. S. Sastry	PHI Learning Private Limited
2	Numerical Methods for Scientific and Engineering Computation	IyengerJain, and Mahinder Kumar	New Age International Publishers.
3	Numerical Mathematical Analysis	Scarborough	Prentice Hall of India.
4	Simulation and Monte Carlo method	R.Y.Rubinstein	John Wiley

Course Code	**MAT625**
Course Title	**Numerical Analysis Lab**
Type of course	Core
L T P	4 0 0
Credits	4
Course prerequisite	Basic knowledge of Computer programming and Computer Algebra System (CAS): MATLAB or MATHEMATICA
Course Objective (CO)	This course is designed to provide understanding of implementation of basic numerical methods for solving different problems viz. nonlinear equations, system of linear equations, interpolation and extrapolation, numerical differentiation and integration, numerical initial and boundary value problems of ordinary differential equations etc. Further, this course will develop programming skills in the students in order to write and implement their own computer programs for solving problems arising in science, engineering and economics.
Course Outcomes(CO)	At the end of the course, the students will be able to 1. Apply their knowledge of computer programming to develop and implement their own computer codes of numerical methods for solving different types of complex problems viz. nonlinear equations, system of linear equations, interpolation and extrapolation, numerical differentiation and integration, numerical initial and boundary value problems of ordinary differential equations etc. 2. Understand different implementation modes of a numerical method in order to solve a given problem efficiently. 3. Analyze and modify computer codes available in the scientific literature. 4. Utilize the symbolic tools of Computer Algebra System (CAS) for example MATLAB or MATHEMATICA independently and in their computer codes for solving a given problem. 5. Develop, select and apply numerical methods as a computer code with the understanding of their limitations so that they can be implemented in order to get acceptable results.

List of Practicals:

1. To find a real root of an algebraic/ transcendental equation by using Bisection method.
2. To find a real root of an algebraic/ transcendental equation by using Regula-Falsi method.
3. To find a real root of an algebraic/ transcendental equation by using Newton-Raphson method.
4. To find a real root of an algebraic/ transcendental equation by using Iteration method.
5. Implementation of Gauss- Elimination method to solve a system of linear algebraic equations.
6. Implementation of Jacobi's method to solve a system of linear algebraic equations.
7. Implementation of Gauss-Seidel method to solve a system of linear algebraic equations.
8. To find differential coefficients of 1st and 2nd orders using interpolation formulae.
9. To evaluate definite integrals by using Newton - Cotes integral formulae.
10. To evaluate definite integrals by using Gaussian Quadrature.
11. To evaluate double integrals by using Trapezoidal and Simpson method.
12. To compute the solution of ordinary differential equations with Taylor's series method.
13. To compute the solution of ordinary differential equations by using Euler's method.
14. To compute the solution of ordinary differential equations by using Runge -Kutta methods.
15. To compute the solution of ordinary differential equations by using Milne-Simpson method.
16. To compute the solution of Boundary value problems of Ordinary Differential Equations by using Finite Difference method.
17. To compute the solution of Boundary value problems of Ordinary Differential Equations by using Shooting method.

Text & Reference books:-

S. No	**Name**	**Author(S)**	**Publisher**
1	Applied Numerical Analysis using MATLAB,	L.V.Fausett	Pearson Prentice Hall
2	Numerical Methods using MATLAB	Mathews, J.H. and Fink, K.D.	Pearson Prentice Hall
3	Object Oriented Programming with C++	Balagurusamy, E	Tata McGraw Hill
4	Numerical Analysis	Conte, S.D. and Boor, C.D.	McGraw Hill,

DISCIPLINE SPECIFIC ELECTIVE SUBJECTS

FOR 3RD SEMESTER

Course Code	**MAT613**
Course Title	**Operations Research-I**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course pre-requisite	B.Sc with Mathematics and B.A with Mathematics
Course Objective (CO)	To inculcate the traits of rational decision making. To develop the research proposal and also find out the optimal solution.
Course Outcomes(CO)	At the end of this course, students will be able to: 1. formulate and solve problems as networks and graphs. 2. construct linear integer programming models and discuss the solution techniques. 3. Design decision models and use some solution methods for nonlinear optimization problems.

UNIT-I

Linear programming problem, properties of a solution to the linear programming problem,generating extreme point solution, simplex computational procedure, development of minimumfeasible solution, the artificial basis techniques, a first feasible solution using slack variables, twophase and Big-M method with artificial variables.

UNIT-II

General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, Linear Programming formulation, solution of transportation problem, test for optimality,degeneracy, transportation algorithm (MODI method), time-minimization transportation problem.

UNIT—III

Replacement of equipment/Asset that deteriorates gradually,replacement of equipment that fails suddenly, recruitment and promotion problem, equipmentrenewal problemMathematical formulation of assignment problem, assignment method, typical assignment problem, the traveling salesman problem.

UNIT-IV

Two-person zero-sum games, maximum minimum principle, games without saddle points(Mixed strategies), graphical solution of$2\times n$ and $m\times 2$ games, dominance property, arithmetic method of

n× *n* games, general solution of *m*× *n* rectangular games .Non Linear Programming Problem :-i.e one and multi variable unconstrained optimization Kuhn -Tucker conditions for constrained optimization .Quadratic , Convex, Non Convex Programming problem

Text & Reference Books:-

S. No	Name	Author(S)	Publisher
1	Linear Programming	S.L.Gass	McGraw Hill Book Company
2	Operations Research	K.K. Chawla	Kalyani Publication
3	Mathematical Programming	N.S. Kambo	East West Press
4	Operations Research	H.A.Taha	Taha, H.A
5	Operations Research	KantiSawrup	Sultan Chand & Sons

Course Code	**MAT615**
Course Title	**Fluid Mechanics-I**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	The objective of this course is to introduce the fundamentals of modern treatment of incompressible and compressible fluid flows.
Course Outcomes(CO)	Studenta will be able to: 1. identify derivation of basic equations of fluid mechanics. 2. describe the motion of fluids. 3. formulate the problems on buoyancy and solve them.

UNIT-I

Real fluids and ideal fluids, velocity of fluid at a point, streamlines, path lines, streak lines, velocity potential, vorticity vector, local and particle rates of change, equation of continuity, incompressible fluid flow, acceleration of fluid, conditions at a rigid boundary.

UNIT-II

Euler's equation of motion, Bernoulli's equation, their applications, some potential theorems, flows involving axial symmetry- stationary sphere in a uniform stream, impulsive motion, Kelvin's theorem of circulation, equation of vorticity.

UNIT-III

Some three dimensional flows: sources, sinks and doublets, images in rigid planes, images in solid spheres, Stoke's stream function.

UNIT-IV

Two dimensional flows: complex velocity potential, Milne Thomson circle theorem and applications, theorem of Blasius, Vortex rows, Karman Vortex Street.

Text & Reference Books:-

S. No	Name	Author(S)	Publisher
1	Text Book of Fluid Dynamics	F.Charlton	GK Publishers,
2	Fluid Mechanics, 2nd Edition	L.D. Landauand E. M. Lifhshitz.	Pergamon Press Ltd
3	An Introduction to Fluid	G.K. Batchelor	Cambridge University

	Mechanics		Press,
4	Fluid Mechanics	P.K. Kundu and I. M. Cohen.	Harcourt (India) Pvt. Ltd.

Course Code	**MAT617**
Course Title	**Topological Vector Spaces**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	To familiarize the students about topic of topological vector spaces
Course Outcomes(CO)	At the end of the course, the students will be able to: 1. define and solve topological vector spaces. 2. explain subspaces, product spaces and quotient space. 3. explain Convex, balanced and absorbing sets.

Unit-I

Definition and examples of topological vector spaces. Convex, balanced and absorbing sets and their properties. Minkowski's functional.

Unit-II

Subspace, product space and quotient space of a topological vector space.

Unit-III

Locally convex topological vector spaces.

Unit-IV

Normableandmetrizable topological vector spaces, Complete topological vector spaces and Frechet space, Linear transformations and linear functional and their continuity.

Text & Reference Books:-

S. No	**Name**	**Author(S)**	**Publisher**
1	Functional Analysis	Walter Rudin	TMH Edition, 1974
2	Topological Vector Spaces	H.H. Schaefer	Springer, N.Y., 1971

Course Code	**MAT629**
Course Title	**Fundamentals of Python**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	Basic knowledge of Programming
Course Objective (CO)	The objective of this course is to develop a basic understanding about the Python Concept
Course Outcomes(CO)	The students will be able to: 1. Interpret the fundamental Python syntax and semantics and be fluent in the use of Python control flow statements. 2. Express proficiency in the handling of strings and functions. 3. Determine the methods to create and manipulate Python programs by utilizing the data structures like lists, dictionaries, tuples and sets.

Unit-I:
Introduction to python and Setting up the Python development Environment, Basic syntax, interactive shell, editing, saving, and running a script,

Unit-II:
Concept of data types, Declaring and using Numeric data types: int, float, complex Lists and Tuples and their basic operations, Python console Input / Output. Arithmetic operators and expressions, Conditions, Comparison operators, Logical Operators, Is and In operators.

Unit-III
String Handling, Unicode strings, Strings Manipulation:- compare strings, concatenation of strings, Slicing strings in python, converting strings to numbers and vice versa. Dictionaries Control statements: if-else, Nested If-Else, Loops (for, while) Loop manipulation using pass, continue, break and else

Unit-IV
Files: Understanding read functions, read(), readline() and readlines() Understanding write functions, write() and writelines() Manipulating file pointer using seek. Introduction to graphics. Simple graphics (Bar, Multiple Bar, Histogram, Pie, Box-Plot, Scatter plot, qqplot).

RECOMMENDED BOOKS			
Sr. no.	**Name**	**AUTHOR(S)**	**PUBLISHER**
1.	Fundamentals of Python:	Kenneth Lambert	Course Technology,
2.	Learning Python	O' Reilly	Mark Lutz
3.	Python Programming: An Introduction to Computer Science 2nd Edition	John Zelly	Mark Lutz

COURSE CODE	**MAT619**
Course Title	**Differential Geometry**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc with Mathematics and B.A with Mathematics
Course Objectives (CO)	The objective of this course is to provide knowledge of differential geometry of curves and surfaces in space, with special emphasis on a geometric point of view, as a basis for further study or for applications.
Course Outcomes(CO)	At the end of the course, students will be able to: 1. analyse the equivalence of two curves by applying some theorems. 2. defines surfaces and their properties. 3. list topological aspects of surfaces.

UNIT-I

Curves, Arc length, Re-parametrization, Level Curves vsParametrized Curves, Curvature, Plane Curves, Space Curves, Simple Closed Curves, The Isoperimetric Inequality, The Four Vertex Theorem.

UNIT-II

Surfaces in three dimensions: Surface, Smooth Surfaces, Tangents, Normals and Orientability, Quadric Surfaces, Triply Orthogonal Systems, Application of Inverse Function Theorem.

UNIT-III

The First Fundamental Form: Lengths of Curves on Surfaces, Isometries of Surfaces, Conformal mappings of Surfaces, Surface Area,Equiareal maps and a Theorem of Archimedes, The Second Fundamental Form,The curvature of Curves on a Surface, The Normal and Principal Curvature, Geometrical interpretation of Principal Curvature.

UNIT-IV

The Gaussian and Mean Curvatures. The Pseudosphere.FlatSurfaces.Sufaces of constant Mean Curvature,Gaussian Curvature of compact Surfaces, The Gauss Map.Geodesic Equations.

Text & Reference Books:

Sr. No.	**Name**	**Author(S)**	**Publisher**
1	Elementary Differential Geometry	Andrew Pressley	Springer
2	Introduction to Differential	T. J. Willmore	Oxford University

	Geometry		Press India, 1997.
3	Differential Geometry: An Integrated Approach.	N. Prakash	US: McGraw-Hill Inc, 1982.

COURSE CODE	**MAT621**
Course Title	**Calculus of Several Variables**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.sc with Mathematics and B.A with Mathematics
Course Objectives (CO)	To extend the concepts from one variable calculus to functions of several variables and vector valued functions and study the continuity, differentiability and integrability of these functions.
Course Outcomes(CO)	Students will be able to: 1. explain differential forms of Rn. 2. Perform integration on Rn. 3. Define and express the continuity, Differentiability on Euclidian space.

UNIT-I

Functions, continuity, and differentiability on Euclidean space R^n: Vector space structure ofR^nover R, norm and inner product, linear transformations, dual spaces; topology of R^n, limit points, continuity, compactness, connectedness, vector valued functions ($f: R^n \rightarrow R^m$), oscillation of functions and continuity; Frechet derivatives, results on chain rule, differentiability, partial derivatives and continuity of Frechet derivatives; the inverse function theorem, implicit function theorem.

Unit – II

Integration on R^n: Partition of a closed rectangle, lower and upper sums, Integral of a function ($f: R^n \rightarrow R$) on a closed rectangle, measure zero and content zero, integrable functions, characteristic function, Fubini's theorem; real-analytic functions, partitions of unity, change of variable.

Unit-III

Differential forms on R^n: Multilinear functions over a finite dimensional vector space V, k-tensors, tensor product, alternating k-tensors, wedge product, vector spaces of k-tensors over R,determinant, orientation and volume element; tangent spaces in R^n, vector fields, differential forms, linear maps between vector spaces of alternating k-tensors, closed differential forms, exact differential forms, Poincare lemma.

Unit-IV

Integration on Chains in R^n: Singular n-cubes and singular n-chains in R^n, results on boundary of a chain, definitions of integral of a function ($f: R^n \rightarrow R$) over a singular n-cube and n-chain, Stokes' theorem on chains.

Text & Reference Books:

S. No.	Name	Author(S)	Publisher
1	Calculus on Manifolds	M. Spivak	Addison Wesley, 1965
2	Introduction to Differentiable Manifolds	S. Lang	Springer, 2002
3	An Introduction to Manifolds	S. Axler, K.A. Ribet	Springer, 2008

Course Code	**MAT623**
Course Title	**Discrete Mathematics**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc with Mathematics and B.A with Mathematics
Course Objective (CO)	The objective of this course is to acquaint the students with the concepts in Discrete Mathematics. It includes the topics like Logics, Graph Theory, Trees and Boolean algebra.
Course Outcomes(CO)	Students will be able to: 1. Understand the notion of mathematical thinking, mathematical proofs, and algorithmic thinking, and be able to apply them in problem solving. 2. Understand some basic properties of graphs and related discrete structures, and be able to relate these to practical examples. 3. use effectively algebraic techniques to analyse basic discrete structures and algorithms.

UNIT-I

Basic logical operations, conditional and bi-conditional statements, tautologies, contradiction, Quantifiers, prepositional calculus, Recursively defined sequences, the characteristic polynomial. Solution of recurrence relations, generating function.Counting Techniques: The product rule, the sum rule, the inclusion–exclusion principle, The Pigeonhole Principle and examples.Simple arrangements and selections, Arrangements and selections with repetitions, Distributions, Binomial Coefficients.

UNIT-II

Language and Grammars: Computability and Formal Languages, Ordered sets, languages, Phrase structure grammars, Types of grammars and languages, Finite state machines-equivalent machines, Finite state machines as language recognizers, Analysis of algorithm-Time complexity.

UNIT-III

Introduction to Graph Theory: Basic Terminology, Special types of Graphs. The Handshaking Theorem, Paths and Circuits Shortest paths.Connectivity of Graphs.Isomorphism of Graphs. HomomorphismGraphs. Eulerian and Hamiltonian Graphs.Planar and Non Planar

Graphs.Euler'sformula.GraphColouring.Adjacency and Incidence Matrices.Travelling Salesman Problem.

UNIT-IV

Trees: Basic Terminology. Binary Trees. Tree Traversing: Pre-order, Post-order and In-order Traversals. Minimum Spanning Trees, Prim's and Kruskal'sAlgorithm.Boolean algebra, Boolean Function, Switching circuit and Logic Gates, K-map. Lattice Theory: Lattices and Algebraic Structures, Lattice as algebraic structures, complete lattices, Sub-lattices, Homomorphism on lattices, Modular lattices.

Text & Reference books:-

S.No	Name	Author(S)	Publisher
1	Discrete Mathematics and its Applications	K.H. Rosen	McGraw Hill
2	Foundation of Discrete Mathematics	K. D. Joshi	J. Wiley & Sons,
3	Discrete Mathematics	P.K.Sharma	Modern Publication
4	Discrete Mathematical Structures with Applications to Computer Science	J. P. Trembley and R. P. Manohar	McGraw Hill

Course Code	**MAT631**
Course Title	**Fractional Calculus**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	Differential Equations (Ordinary and Partial), Mathematical Methods
Course Objective (CO)	The objective of this course to cover the basics of the fractional calculus, or more aptly called the calculus of derivatives and integrals to an arbitrary order. Then introduce the concept of fractional differential equations and consider some of their applications. Also, study the numerical solution of fractional differential equations
Course Outcomes(CO)	At the end of the course, the students will be able to 1. understand the Riemann-Liouville fractional integral and evaluate fractional integrals of some common functions 2. define the Riemann-Liouville and Caputo fractional derivatives and find the fractional derivatives of some common functions 3. state sufficient conditions under which the fractional integrals and derivatives exist 4. investigate some applications of the fractional calculus to the real world. 5. solve linear fractional differential equations using the Laplace transform and Fourier Transforms

UNIT-I

Special Functions of the Fractional Calculus. Gamma Function. Mittag-Leffler function, Fractional Derivatives and Integrals. Grunwald-Letnikov Fractional Derivatives. Riemann Liouville Fractional Derivatives. Some Other Approaches.

UNIT-II

Geometric and Physical Interpretation of Fractional Integration and Fractional Differentiation. Sequential Fractional Derivatives. Left and Right Fractional Derivatives. Properties of Fractional Derivatives. Laplace Transforms of Fractional Derivatives. Fourier Transforms of Fractional Derivatives. Mellin Transforms of Fractional Derivatives.

UNIT-III

Linear Fractional Differential Equations. Fractional Differential Equation of a General Form. Existence and Uniqueness Theorem as a Method of Solution. Dependence of a Solution on Initial Conditions. The Laplace Transform Method. Standard Fractional Differential Equations. Sequential Fractional Differential Equations.

UNIT-IV

Other Methods for the Solution of Fractional-order Equations. The Mellin Transform Method. Power Series Method. Babenko's Symbolic Calculus Method. Numerical Evaluation of Fractional Derivatives. Approximation of Fractional Derivatives.

Text & Reference books:-

S.No	Name	Author(S)	Publisher
1	Matrix approach to discrete fractional calculus	I. Podlubny	Fractional Calculus and Applied Analysis
2	Fractals and fractional calculus in continuum mechanics	A. Carpinteri, F. Mainardi	Springer-Verlag
3	An introduction to the fractional calculus	Miller K.S., Ross B	John Wiley
4	The fractional calculus	K. B. Oldham, J. Spanier	Academic Press

Course Code	**EVS003**
Course Title	**Natural Hazards and Disaster Management**
Type of course	Theory Course
L T P	3 0 0
Credits	3
Course prerequisite	Graduation
Course Objective	To learn about natural hazards, risk assessment and disaster management
Course Outcomes	The students will be able to: Understand the current overview of natural hazard materials. Discuss the physical aspects of vulnerability and elements of risk mapping, assessment. Propose development planning, sustainable development in the context of Climate Change.

Syllabus

Unit I

Overview of natural hazards; Introduction to natural hazards, impact and mitigation in Global and Indian context; causes and consequences of geological hazards, flood, drought and climate change issues, forest hazard, tsunami and coastal hazards, cyclone hazards, snow avalanche, GLOF and glacier related hazards, extreme weather events, urban and industrial hazards.

Unit II

Introduction to vulnerability and risk assessment, socio-economic and physical aspects of vulnerability and elements of risk mapping, assessment, and reduction strategies.

Unit III

Earth observation: Data availability and key operational issues for DM: EO systems for natural hazards study: present (operational) and future systems; multi-temporal data sources, multi-temporal database organisation: Key operational issues, utilisation of geo-information products for disaster management (available through International cooperation e.g. International Charter etc.)

Unit IV

Disaster management framework of India and recent initiatives by Govt. of India with special emphasis on DRR HFA 2005-2015, MDG and SAARC comprehensive framework for DRR Disaster Management Support (DMS): Status in India for use of space inputs Mainstreaming DRR in Development Planning Sustainable development in the context of Climate Change Disaster Recovery-Strategy and case examples.

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Environmental Hazards : Assessing Risk and Reducing Disaster	Keith Smith and Petley David, 2008.	Routledge
2	Geo-information for Disaster Management	van Oosterom Peter, Zlatanova Siyka and Fendel Elfriede, 2005	Springer-Verlag
3	Geospatial Techniques in Urban Hazards and Disaster Analysis	Showalter, Pamela S. and Lu, Yongmei, 2010.	John Wiley and Sons.
4	An International Perspective on Natural Disaster: Occurrence, Mitigation and Consequences	Stoltman JP, Lidstone J and Dechano LM., 2004.	Kluwer Academic Publishers

SEMESTER IV

Course Code	**MAT 602**
Course Title	**Functional Analysis**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc with Mathematics and B.A with Mathematics
Course Objective (CO)	This course is an introduction to Banach Spaces and Hilbert Spaces along with various operators/functional so as to enable the students to study advanced topics in Functional Analysis
Course Outcomes(CO)	At the end of the course, students will be able to: 1. Apply the theory of functional analysis in the qualitative study of different mathematical models in Biological and Ecological systems and different engineering problems. 2. This will help the students to study the stability theory of Differential equations and difference equations. 3. Understand the concept of topology in real world problems. 4. Applications of topological approach in the study of solutions of Difference Equations in different boundary value problems arising in Biological and Ecological systems and different engineering problems. 5. Use of topological concepts in Architecture Engineering.

UNIT-I

Normed Linear Spaces, L P -Spaces: Holder's And Minkowski's Inequalities, Banach Spaces, Subspaces, Quotient Spaces,, Convergence And Completeness, Hahn Banach Theorem, Open Mapping Theorem, Closed Graph Theorem, Baire Category Theorem, Banach Steinhauns Theorem (Uniform Boundedness Principle), Boundedness and Continuity Of Linear Transformation, Riesz-Fischer Theorem

UNIT-II

Projections on a Hilbert space: Spectral Theorem for normal operators, Compact linear operators on normed spaces, properties of Compact linear operators.

UNIT-III

Natural Imbeding N into N^{**} :Dual Spaces, embedding in second dual.The conjugate space N*.The Hahn-Banach theorem and its consequences. Natural imbedding of N into N**, reflexivity of normed spaces, Open mapping theorem.

UNIT-IV

Hilbert and Banach Spaces: Hilbert space, orthonormal basis, Bessel's inequality, Riesz Fischer theorem, Parseval's identity, bounded Linear functionals; projections, Riesz Representation theorem, adjoint operators, self adjoint, normal, unitary and isometric operators.

Text & Reference books:-

S. No	Name	Author(S)	Publisher
1	Functional analysis	P K Sharma	Sharma publications
2	Functional Analysis	P K Jain , O P Ahuja	New Age International (P) Khalil Ahmed Ltd
3	Functional analysis	V Balmohan	New Age International Limited

Course Code	**MAT604**
Course Title	**Number Theory**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	To give a simple account of classical number theory, prepare students in number theory and algebra and to demonstrate applications of number theory
Course Outcomes(CO)	After the completion of the course, students will be able to: 1. Apply the knowledge of Number theory to attain a good mathematical maturity and enables to build mathematical thinking and skill. 2. Utilize the congruences, Chinese remainder theorem, indices, residue classes, Legendre symbols to solve different related problems. 3. Identify and analyze different types of divisibility tests, Euler's theorem, Wilson theorem, Mobius inversion formula to formulate and solve various related problems. 4. Design, analyze and implement the concepts of Diophantine equations for solving different types of problems, for example, sum of two and four squares. 5. Identify the challenging problems in modern mathematics and find their appropriate solutions.

UNIT-I

Simultaneous Linear Congruence, Chinese Remainder theorem with applications,Wolsten-Holme'stheorem,Lagrange'sproofofWilsontheorem,Fermatnumbers,The order of an integer modulo Primitive roots, Existence and number of primitive roots.

UNIT-II

Indices and their applications, Quadratic residues, Euler's criterion, Product of quadratic residues and quadratic non-residues, The Legendre symbol and its properties, Gauss's Lemma, Quadratic reciprocity law, Jacobian symbol and its properties.

UNIT-III

Criterion for an integer to be expressible as sum of two squares and sum of four squares, Farey series, Farey dissection of a circle and its applications to approximations of irrationals by rational.

UNIT-I V

Finite and Infinite simple continued fractions, periodic and purely periodiccontinued fractions, Lagrange's Theorem on periodic continued fractions.applications to Pell's equation.The fundamental solution of Pell's equation.

Text & Reference Books

S. No	Name	Author(S)	Publisher
1	Theory of Numbers	Hardy and Wright	McGraw-Hill Ltd
2	An introduction to number theory	Niven and Zuckerman	S.Chand
3	Elementary Number Theory, McGraw Hill 2002.	Burton, M.David	McGraw Hill
4	Theory of Numbers	Randhir Singh	Sharma Publication

Course Code	**MAT 606**
Course Title	**Field Extensions and Galois Theory**
Type of course	Core
L T P	5 0 0
Credits	5
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	To draw an attention on various results of the different algebraic structures, in particular, extension fields, splitting fields, separable and inseparable extension, Galois extensions and cyclotomic extensions.
Course Outcomes (CO)	At the end of the course, students will be able to: 1. understand Galois Theory properly. 2. Get Experience of interpreting the result. 3. Demonstrate mastery of the basic elements of Galois Theory.

UNIT-I

Fields, Characteristic of a field, prime fields, finite field extensions, degree of a field extension, Algebraic extensions, splitting fields: Existence & Uniqueness.

UNIT-II

Algebraic closure, Algebraically closed fields. Finite fields, Existence of GF(p_n), Construction of finite fields. Separable and purely inseparable extensions, Perfect fields,

UNIT-III

Simple extensions, Primitive elements, Lagrange's theorem on primitive elements, Normal extensions, Roots of unity. Galois extensions, The fundamental theorem of Galois theory,

UNIT-IV

Cyclotomic extensions, Abelian extensions, cyclic extensions, Frobenius mapping, Galois groups of finite fields, Quintic equations and solvability by radicals, Constructive polygons.

Text & Reference Books

S. No	**Name**	**Author(S)**	**Publisher**
1	A first course in	J.B. Fraleigh	Narosa Publishing House,

	Abstract Algebra		New Delhi.
2	Abstract Algebra	D.S. Dummit and R. M. Foote	John-Wiely and Sons StudentsEdition-1999
3	Basic Abstract Algebra	P.B. Bhattacharya, S. K. Jain and S. R. Nagpal	Cambridge University Press, 1997
4	Modren Algebra	S. Singh and Q. Zameeruddin	Vikas Publishing House, New Delhi

DISCIPLINE SPECIFIC ELECTIVE SUBJECTS

FOR 4TH SEMESTER

Course Code	**MAT616**
Course Title	**Operations Research-II**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course pre-requisite	B.Sc with Mathematics and B.A with Mathematics
Course Objective (CO)	To inculcate the traits of rational decision making. To develop the research proposal and also find out the optimal solution
Course Outcomes(CO)	At the end of the course, students will be able to: 1. use this knowledge to become entrepreneur 2. Apply different methods to solve different problems based in real life situations 3. Devise the optimal solution to gain more profit

UNIT-I

Queuing Theory :-Introduction, Queuing System, elements of queuing system, distributions of arrivals, inter arrivals, departure and service times. Classification of queuing models, single service queueing model with infinite capacity (M/M/1): (/FIFO).Queuing Models: (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process, (M/M/C)(/FIFO), (M/M/C) (N/FIFO), (M/M/R) (KIGD), Power supply model.

UNIT-II

Inventory Control:- The inventory decisions, costs associated with inventories, factors affecting Inventory control, economic order quantity (EOQ), Deterministic inventory problems with no shortage and with shortages, EOQ problems with price breaks, Multi item deterministic Problems

UNIT-III

Simulation Models:-Need of simulation, methodology of simulation. Simulation models, event-type simulation, generation of random numbers, Monto-Carlo simulation, simulation of inventory problems. queuing systems, maintenance problem, job sequencing.

UNIT-IV

Integer Programming:-Gomory's all I.P.P. method, constructions of Gomory's constraints, Fractional cut method-all integer and mixed integer, Branch-and-Bound method, applications of integer programming.

Text & Reference Books:-

S. No	Name	Author(S)	Publisher
1	Linear Programming	S.L. Gass	McGraw Hill Book Company
2	Operations Research	K.K.Chawla	Kalyani Publication
3	Mathematical Programming	N.S. Kambo	East West Press
4	Operations Research	H.A. Taha	
5	Operations Research	KantiSawrup	Sultan Chand & Sons

Course Code	**MAT618**
Course Title	**Fluid Mechanics-II**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc with Mathematics and B.A with Mathematics
Course Objective (CO)	This course is designed to make the students learn to develop mathematical models of fluid dynamical systems and use mathematical techniques to find solutions to these models.
Course Outcomes(CO)	Students will be able to: 1. Acquire thorough knowledge of integral 2. Attain thorough knowledge of Bessel's functions. 3. Apply Legendre's functions during research

UNIT-I

Stress components in a real fluid, relation between Cartesian components of stress, rate of strain quadric and principal stresses, relations between stress and rate of strain, coefficient of viscosity and laminar flow.

UNIT-II

The Navier-Stokes equations of motion of a viscous fluid, steady motion of viscous fluid between parallel planes, steady flow through tube of uniform circular cross-section, flow through tubes of uniform cross section in the form of circle, ellipse and equilateral triangle.

UNIT-III

Diffusion of vorticity. Energy dissipation due to viscosity, steady flow past a fixed sphere, dimensional analysis, Reynolds numbers, Prandtl's boundary layer, Karman integral equation.

UNIT-IV

Elements of wave motion, waves in fluids, Surface gravity waves, standing waves, group velocity, energy of propagations, path of particles, waves at interface of two liquids.

Text & Reference Books:-

S. No.	Name	Author(S)	Publisher
1	Text Book of Fluid Dynamics	F. Charlton	GK Publishers
2	Fluid Mechanics, 2nd Edition.	L.D. Landau and E. M. Lifhshitz	Pergamon Press Ltd
3	An Introduction to Fluid Mechanics.	G. K. Batchelor	Cambridge University Press
4	Fluid Mechanics	P.K. Kunduand I. M. Cohen.	Harcourt (India) Pvt. Ltd

Course Code	**MAT620**
Course Title	**Special Functions**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.sc with Mathematics and B.A with Mathematics
Course Objective (CO)	To provide an introduction to the different Bessel's functions, Legendre's functions.
Course Outcomes(CO)	Students will be able to : 1. Apply various methods to obtain accurate results in Engg. Problems 2. Analyse student learning in mathematics. 3. Implement knowledge of special functions to create various software.

UNIT-I

Bessel's functions of first and second kind, Recurrence relations, Generating functions, Trigonometric expansions, Asymptotic expansion, Neumann Expansion theory.

UNIT-II

Legendre's functions, Laplace integral for the Legendre Polynomials, Generating functions, Recurrence relations, Orthogonality, solution of Legendre's equations, Hermite Polynomials, Recurrence relations, Rodrigue formula.

UNIT-III

Hypergeometric function, solution of hypergeometric equation, Kummer function and it'sasymptotic expansion, Barnes Contour Integral,

UNIT-IV

Integral representation, Gauss Theorem, Kummer's theorem, Vandermonde's theorem.

Text & Reference Books:-

S.No	**Name**	**Author(S)**	**Publisher**
1	The Special Functions and Their Approximation.	Y.P. Luke	Academic Press
2	Special Functions.	F. D. Rainville	Chelsea Pub Co
3	The Theory of Functions	E.C. Titchmarh	Oxford Science Publications

Course Code	**MAT630**
Course Title	**Introduction to R Programming**
Type of Course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course Prerequisites	Statistical analysis
Course Objective(s)	This subject gives an overview of Statistical analysis, graphics representation and reporting.
Course Outcomes (CO)	The students will be able to: 1. Access online resources for R and import new function packages into the R workspace. 2. Import, review, manipulate and summarize data-sets in R. 3. Explore data-sets to create testable hypotheses and identify appropriate statistical tests.

Unit-I:

Introducing to R, Help functions in R, Vectors, Common Vector Operations, Using all and any function, subletting of vector. Creating matrices,

Unit-II:

Creating matrices, Matrix operations, Applying Functions to Matrix Rows and Columns, Adding and deleting rows and columns , lists, Creating lists, general list operations, Accessing list components and values, applying functions to lists, recursive lists

Unit-III

Input/ Ouput: scan() , readline() Function, Printing to the Screen Reading and writing CSV and text file. Control statements: Loops, Looping Over Nonvector, Sets, if-else , writing user defined function, scope of the variable, R script file

Unit-IV:

Graphics in R: Graph Syntax ((title, xlabel, ylabel, pch, lty, col.), Simple graphics (Bar, Multiple Bar, Histogram, Pie, Box-Plot, Scatter plot, qqplot), Low-level and High-Level plot functions, par() command to generate multiple plots.

Practical: Based on simple mathematical problems and based on syllabus of Statistical Methods for descriptive Statistics

RECOMMENDED BOOKS

Sr. no.	Name	AUTHOR(S)	PUBLISHER
1.	The R Student Companion	Dennis, B. (2013)	Taylor & Francis Group
2.	R for Everyone: Advanced Analytics and Graphics	William. Lander, J. P.	Addison- Wesley Data
3.	The Art of R Programming	Matloff, N.	Statistical Software Design

Course Code	**MAT622**
Course Title	**Advanced Numerical Analysis**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.sc with Mathematics and B.A with Mathematics
Course Objective (CO)	To provide an introduction to the different advanced classical numerical methods.
Course Outcomes(CO)	Students will be able to: 1. Apply various methods to obtain accurate results in Engg. Problems. 2. Acquire coherent knowledge of advanced numerical analysis. 3. Apply knowledge of numerical analysis to development of software.

UNIT-I

Finite difference approximation to partial derivatives, parabolic equations: An explicit method, crank Nicolson Implicit method, solution of implicit equations by Gauss Elimination, derivative boundary conditions, local truncation error, Convergence and stability.

UNIT-II

Hyperbolic equations: Implicit difference methods for wave equation solution of advection equation by finite difference method and Maccormack method, stability analysis, Lax, Wendroff explicit method on rectangular mesh for 1st order equations, Iterative methods for elliptic equations.

UNIT-III

Finite element methods: Rayleigh Ritz Method, the collocation and Galerkin's Method, finite element methods for ODE's.

UNIT-IV

Finite element methods for one dimensional and two dimensional problems, Introduction to F. E. M. for partial differential equations.

Text &Reference Books:-

S.No	**Name**	**Author(S)**	**Publisher**
1	Numerical Solution of Partial Differential Equations	G. D. Smith	Oxford University Press, U.S.A
2	Friendly Introduction to Numerical Analysis	B. Bradie	Pearson

3	An Introduction to Finite Element Methods	N. Reddy	McGraw Hill Education

Course Code	**MAT624**
Course Title	**Fuzzy Set theory**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc with Mathematics and B.A with Mathematics
Course Objective (CO)	The objective of this course is to teach the students the need of fuzzy sets, arithmetic operations on fuzzy sets, fuzzy relations, possibility theory, fuzzy logic, and its applications
Course Outcomes(CO)	Students will be able to: 1. Use the knowledge of fuzzy mathematics in real life situations based on credit & debit. 2. Apply the knowledge of fuzzy mathematics in economics & Engg. 3. Develop & Enhance reasoning ability in students .

UNIT-I

Classical and Fuzzy Sets: Overview of classical sets, Membership function, A-cuts, Properties of a-cuts, Extension principle.

UNIT-II

Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of operations, Aggregation operations. Fuzzy Arithmetic: Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals and numbers, Fuzzy equations.

UNIT-III

Fuzzy Relations: Crisp and fuzzy relations, Projections and cylindric extensions, Binary fuzzy relations, Binary relations on single set, Equivalence, Compatibility and ordering Relations, Morphisms, Fuzzy relation equations.

UNIT-IV

Fuzzy Logic: Classical logic, Multi-valued logics, Fuzzy propositions, Fuzzy qualifiers, Linguistic hedges. Applications of Fuzzy Logic: Washing machines, Control systems engineering, Power engineering and Optimization.

Text & Reference Books:-

S.No	Name	Author(S)	Publisher
1	Fuzzy Sets	G. J. Klirand T.A. Folger	Uncertainty and Information, PHI
2	Fuzzy Set Theory and its Applications	H.J. Zimmermann	Allied Publishers
3	Fuzzy Sets and Fuzzy logic	G.J. Klirand B. Yuan	Theory and Applications, PHI

Course Code	**MAT626**
Course Title	**Advanced Complex Analysis**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Mathematics or B.A with Mathematics
Course Objective (CO)	The course will continue the study of complex analysis and introduce more advance methods like the Greens functions, MittagLeflers Expansion, Monodromy theorem and the Harmonic methods.
Course Outcomes (CO)	Students will be able to: 1. understand the fundamental concepts of complex analysis and their role in modern mathematics and applied contexts. 2. Demonstrate accurate and efficient use of complex analysis techniques. 3. Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from complex analysis. 4. Apply problem-solving using complex analysis techniques applied to diverse situations in physics, engineering and other mathematical contexts. 5. formulate and prove theorems concerning analytic functions.

UNIT-I

Normal families of analytic functions. Montel's theorem, Hurwitz's theorem, Riemann Mapping theorem, Univalent functions. Distoration and growth theorems for the class S of normalized univalent functions, Koebe 1/4 theorem, Bieberbach Conjecture (statement only) Littlewood's inequality for the class S. Coefficient inequalities for functions in S in case of real coefficients only.

UNIT-II

Principle of analytic continuation, The general definition of an analytic function. Analyticcontinuation by power series method.Naturalboundary.Schwarz reflection principle, Monodromytheorem.Mittag-Leffler's theorem (only in the case when the set of isolatedsingularities admits the point at infinity alone as an accumulation point). Cauchy's

method ofexpansion of meromorphic functions. Partial fraction decomposition of cosec Z, Representationof an integral function as an infinite product.Infinite product for sin z.

UNIT-III

The factorization of integral functions, Weierstrass theorem regarding construction of an integral function with prescribed zeros. The minimum modules of an integral function, Hadamard's three circle theorem, The order of an integral function, Integral functions of finite order with no zeros. Jensen's inequality. Exponent of convergence.

UNIT-IV

Borel's theorem on canonical products, Hadmard's factorization theorem, Basic properties of harmonic functions, maximum and minimum principles, Harmonic functionson a disc, Harnack'sinequality and theorem, Subharmonic and superharmonic functions, Dirichlet problem, Green's function.

Text &Reference Books:-

S. No	**Name**	**Author(S)**	**Publisher**
1.	Functions of one complex variable. Springer-Verlag	J. B. Conway	International student edition, Narosa Publishing House, 1980 (Chap.X only)
2.	Theory of Functions of a Complex Variable	E. T. Copson	(Oxford University Press), Chapter IV (4.60, 4.61, 4.62) Chap. VII (excl. Section 7.7) Chap.VIII (Section 8.4)

Course Code	**MAT632**
Course Title	**Coding Theory**
Type of course	Discipline Specific Elective
L T P	4 0 0
Credits	4
Course prerequisite	Linear Algebra, Probability theory
Course Objective (CO)	Coding Theory helps to detects errors in Transmission of messages. In this course we introduce the basic concepts of Coding Theory such as, Double Error-Correcting B.C.H. code, Cyclic codes, The Group of a code, Quadratic residue codes and Bose-Chaudhuri- Hocquenghem codes.
Course Outcomes (CO)	At the end of the course, the students will be able to 1. understand the concept of Maximum-Likelihood Decoding and Syndrome Decoding. 2. analyze Double Error-Correcting B.C.H. code and Finite Fields Polynomials. 3. understand Cyclic Codes. 4. study the concept of Bose-Chaudhuri-Hocquenghem (*B.C.H.*) Codes and Weight Distributions. 5. Understand basic techniques of algebraic coding theory like matrix encoding, polynomial encoding, and decoding by coset leaders etc.

Unit-I

Introduction to Coding Theory: Code words, distance and weight function, Nearest-neighbour decoding principle, Error detection and correction, Matrix encoding techniques, Matrix codes, Group codes, decoding by coset leaders, Generator and parity check matrices, Syndrome decoding procedure, Dual codes.

Unit-II

Linear Codes: Linear codes, Matrix description of linear codes, Equivalence of linear codes, Minimum distance of linear codes, Dual code of a linear code, Weight distribution of the dual code of a binary linear code, Hamming codes.

Unit-III

BCH Codes: Polynomial codes, Finite fields, Minimal and primitive polynomials, Bose-Chaudhuri- Hocquenghem codes.

Unit-IV

Cyclic Codes: Cyclic codes, Algebraic description of cyclic codes, Check polynomial, BCH and Hamming codes as cyclic codes. Maximum distance separable codes, Necessary and sufficient conditions for MDS codes, Weight distribution of MDS codes, An existence problem, Reed-Solomon codes.

Text &Reference Books:-

S. No	**Name**	**Author(S)**	**Publisher**
1.	Elements of Algebraic Coding Theory	L.R.Vermani	Chapman and Hall
2.	Introduction to the Theory of Error Correcting Codes	Vera P.	John Wiley and Sons
3.	Coding and Information Theory	Roman Steven	Springer Verlag
4.	The Mathematics of Coding Theory	Garrett Paul	Pearson Education