झारखण्ड केन्द्रीय विष्वविद्यालय
CENTRAL UNIVERSITY OF JHARKHAND
(भारतीय संसद के अधिनियम 2009 द्वारा स्थापित)
(Established by an Act of Parliament of India in 2009)
Homepage:http://www.cuj.ac.in

Course Curriculum and Syllabus
(As per NEP-2020)

For

5 Years Integrated in M.Sc. in Mathematics

Effective from Session 2022-23

Department of Mathematics
School of Natural Sciences
Central University of Jharkhand, Ranchi 835222, Jharkhand

About the Department

The Department of Mathematics (as Centre for Applied Mathematics) was started in July 2009 under the School of Natural Sciences of Central University of Jharkhand. This department was first in Jharkhand to offer 5 years integrated M.Sc. programs in Applied Mathematics from the year 2009 to 2016. It has started M. Sc. Program in Mathematics since 2017. It also offers PhD. program in Mathematics and allied subjects since the year 2013. From the year 2022, it has started again offering integrated B.Sc.-M.Sc. in Mathematics.

Mission of the Department

- To advance the logical, analytical thinking and development of scientific practice with applications among the students in order to produce mathematical scholars so that they can flourish themselves in areas of Pure and Applied Mathematics, Financial mathematics, Computer Science, Scientific Computing, Statistical Methods, Information Technology and Actuarial Science etc.

Vision of the Department:

- The department aims to provide high-quality education in mathematics at all levels, from undergraduate to graduate studies. This includes fostering a deep understanding of mathematical concepts, promoting critical thinking skills, and preparing students for a wide range of careers or further academic pursuits.
- A strong emphasis is placed on advancing the frontiers of mathematical knowledge through research. This involves both fundamental research aimed at solving theoretical problems and applied research addressing real-world challenges. The department seeks to foster a vibrant research community, where faculty and students collaborate on cutting-edge projects and contribute to the global body of mathematical knowledge. The department strives to earn regional recognition for its expertise in the field of mathematics and the teaching of mathematics.

Program Name: Integrated B.Sc. and M.Sc. in Mathematics

Eligibility Criteria for Admission:

Passed 10+ 2 or equivalent examination in Science stream or equivalent with Mathematics as one of the optional subject having minimum 55% marks or equivalent grade in aggregate for General and EWS category and 50% or equivalent grade in aggregate for SC/ST/OBC (non-creamy layer)/ PWD Categories.

Intake Capacity: 43

About the Program

The Department has started offering a five years Integrated Degree program for its students as per NEP 2020 curriculum framework. The program offers rigorous coursework ensuring a strong foundational base. In addition to a number of core basic courses, students are required to complete at least few advanced courses. The course has been offered with a major in Mathematics with minor subjects such as Physics, Chemistry, Statistics, Life Science, Environmental Sciences, Geography, Economics, and Computer Science etc. The program curriculum would undergo periodic reviews, upgrades and changes, bearing in mind the rapid change in industry and R&D demands.

Under this program, a provision for multiple entry and exit at various levels has been incorporated to fulfill the mandate of NEP 2020. A student can get an Undergraduate Certificate, Undergraduate Diploma, B.Sc., B.Sc. with honors at different levels of exit, otherwise, Integrated M.Sc. Degree directly at the end of 5 years after completing the mandatory course and credit requirements.

- "***Undergraduate Certificate***" in Mathematics will be awarded in case of opting out after 1 year.
  (Additional 4 credits has to be earned at the end of 1st year to eligible for "***Undergraduate Certificate***")
- "***Undergraduate Diploma"*** in Mathematics will be awarded in case of opting out after 2 years.
  (Additional 4 credits has to be earned at the end of 2nd year to eligible for "***Undergraduate Diploma"***)
- "***Bachelor's in Science (B.Sc.)***" degree in Mathematics will be awarded in case of opting out after 3 years. Students need to gain total credits required in the range of 120-128.
  The students will be promoted to "***B.Sc. with Honors***" **only if he/she has cleared all the previous papers and secures 7.50 or above CGPA.**
- "***B.Sc. with Honors***" degree in Mathematics will be awarded in case of opting exit after 4th year. Students need to gain total credits required in the range of 163-168.
- "**Integrated B. Sc. And M.Sc.**" degree will be awarded in Mathematics after 5th year. Students need to gain total credits required in the range of 223-228.

***Notwithstanding the exit and entry policy and nomenclature of the certificates mentioned here, the university regulations in this regard will supersede these regulations.**

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Name of the Department: Mathematics
Name of the School: Natural Sciences
Programme Name: Integrated UG-PG in Mathematics

Details of Course Syllabi Mapped with COs (For Integrated Programme I-X)
SEMESTER WISE STRUCTURE

Course Structure Details

Programme Name	:	**UG-PG in Mathematics**
Programme Objective (POs)	:	**Program Objectives (POs):** Program Objectives (POs) for a Integrated UG-PG in Mathematics outline the expected accomplishments and career aspirations of graduates of the program. These objectives serve as benchmarks for evaluating the effectiveness of the program in preparing students for their professional roles and future endeavours. Some potential Program Objectives for an Integrated UG-PG in Mathematics: - **PO 1:** To provide students with a solid foundation in core mathematical concepts, theories, and techniques across various branches of mathematics including calculus, algebra, analysis, geometry, Numerical Analysis and applied mathematics. - **PO 2:** To enable students to delve deeper into specialized areas of mathematics such as number theory, topology, differential equations, mathematical modeling, Numerical Analysis, optimization, and cryptography, among others. - **PO 3:** To develop students' ability to analyze complex problems, formulate mathematical models, and apply appropriate mathematical methods and algorithms to solve them effectively. - **PO 4:** To foster critical thinking skills and logical reasoning abilities essential for mathematical analysis and rigorous proofs, enabling students to develop sound arguments and justify mathematical assertions. - **PO 5:** To prepare students for research-oriented careers by introducing them to the research process, encouraging independent inquiry, and providing opportunities to engage in research projects under the guidance of faculty mentors.
Programme outcome	:	- **PO 1:** The program will enable students with a deep understanding of basic and applied mathematical concepts, theories and their applications. - **PO 2:** It will enable the students to think independently, analyze complex problems and solve them.

		➢ **PO 3:** It will enable students to conduct independent research, develop appropriate mathematical algorithms to solve problems in different branches of mathematics.
Programme Specific Outcome (SPOs)	:	**Program Specific Outcomes (PSOs)** for an Integrated UG-PG in Mathematics specify the specific knowledge, skills, and attributes that graduates of the program should possess upon completion. These outcomes provide a more detailed framework for assessing the attainment of the program's educational objectives. Here are some potential Program Specific Outcomes for an Integrated UG-PG in Mathematics: ➢ **PO 1:** Quality professionals in Mathematics who fulfill the educational objectives of the program and meet the missions of the University and the Department. ➢ **PO 2:** Graduates should demonstrate a deep understanding of advanced mathematical concepts across various branches such as algebra, calculus, analysis, differential equations, discrete mathematics, and geometry. ➢ **PO 3:** Students should be proficient in applying mathematical reasoning and problem-solving techniques to analyze and solve complex mathematical problems across different domains, including pure and applied mathematics. ➢ **PO 4:** Graduates should be able to conduct independent research, analyze mathematical problems critically, and develop innovative solutions using appropriate mathematical methodologies and tools. ➢ **PO 5:** Students should possess strong computational skills and be proficient in using mathematical software, programming languages, and computational tools for modeling, simulation, and data analysis. ➢

Semester-I

Course Code	Title of the Course	Course Type	Credit
MAT 011010	Analysis-I	Major-1	3
MAT 011030	Linear Algebra	Major-2	2
MAT 021010*	Analysis and Linear Algebra	Minor-1	4
MAT 031030#	Mathematics In Everyday Life	MDC-1	3
		AEC-1	2
MAT 051010#	Quantitative Aptitude and Logical Thinking	SEC-1	3
		VAC-1	3
		Total Credits	20

Semester-II			
Course Code	**Title of the Course**	**Course Type**	**Credit**
MAT011020	Differential Equations-I	Major-3	3
MAT011040	Group Theory	Major-4	2
MAT021020*	Differential Equations-I	Minor-2	4
MAT 031040#	Mathematics In Everyday Life	MDC-2	3
		AEC-2	2
MAT 051020#	Quantitative Aptitude and Logical Thinking	SEC-2	3
		VAC-2	3
		Total Credits	20
Semester-III			
MAT 012010	Probability-I	Major-5	4
MAT 012030	Calculus	Major-6	4
MAT 022010*	Calculus	Minor-3	4
MAT 032030	Mathematics in Everyday Life	MDC-3	3
		AEC-3	2
		SEC-3	3
		Total Credits	20
Semester-IV			
MAT 012020	Statistics-I	Major-7	4
MAT 012040	Partial Differential Equations-I	Major-8	4
MAT 012060	Number Theory	Major-9	4
MAT 012080	Optimization Techniques-I	Major-10	2
MAT 022020*	Partial Differential Equations-I	Minor-4	4
		AEC-4	2
		Total Credits	20

Semester-V			
MAT 013010	Numerical Analysis with Lab-I	Major-11	4
MAT 013030	Differential Equations-II	Major-12	2
MAT 013050	Probability-II	Major-13	4

	Moocs courses	Major-14: Elective-I	4
MAT 053010	Summer Internship	SEC-4	2
MAT 023010*	Numerical Analysis with Lab-I	Minor-5	4
		Total Credits	20
Semester-VI			
Course Code	Title of the Course	Course Type	Credit
MAT 013020	Statistics-II	Major-15	4
MAT 013040	Complex Analysis	Major-16	4
MAT 013060	Mechanics – I	Major-17	4
MAT 023040*	Complex Analysis	Minor-6	4
	Moocs courses	Major-18 Elective-II	4
		Total Credits	20
Semester-VII			
MAT 014010	Mathematical Analysis	Major-19	4
MAT 014030	Numerical Analysis with Lab-II	Major-20	4
MAT 014050	Differential Equations-II	Major-21	4
MAT 024010*	Differential Equations-II	Minor-9	4
MAT 024030*	Graph Theory	Minor-10	2
		Major-22: Elective-III	4
		Total Credits	22
Semester-VIII			
		Major-23: Elective-IV	4
		Major-24: Elective-V	4
		Major-25: Elective-VI	4
MAT 084020	Project	Project	12
		Total Credits	24
Semester-IX			
MAT 015010	Measure Theory and Integration	Major-26	4
MAT 015030	Partial Differential Equations-II	Major-27	4
MAT 015050	Topology	Major-28	4
MAT 015070	Calculus of Variations and Integral Equations	Major-29	4
		Major-30: Elective-VII	4
		Major-31: Elective-VIII	4
		Total Credits	24
Semester-X			
MAT 015020	Functional Analysis	Major-26	4
MAT 015040	Optimization Techniques-II	Major-27	4
MAT 015060	Advanced Linear Algebra	Major-28	4

		Major-32: Elective-IX	4
		Major-33: Elective-X	4
		Total Credits	20

TOTAL CREDITS AFTER 5th YEAR=218

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DETAILED SYLLABUS

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 011010	**Analysis-I**	Major	L	3	T	0	P	0	3
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The general goal of this course is to provide the background information in Analysis. It comprehensively studies the real number system, as well as functions on real numbers, including differential and integral calculus of one variable. This course also provides prerequisite training for other advanced-level courses in, Calculus, real analysis and topology.

Course Outcomes (COs): After completion of this course, the students shall be able to:
1. After completion of this course students will be able to demonstrate competence with elementary properties of real numbers, sets, functions, sequences, and series. Students learn analysis of single variable functions: continuity, differentiability integration of the functions. One of the major outcomes of this course is to demonstrate skills in communicating mathematics.

Unit – 1	The language of sets and functions. Calculus of functions of a single variable- Rates of change and limits, types of limits and asymptotes, continuity; attainment of supremum and infimum of a continuous function on a closed bounded interval, uniform continuity, absolutely continuous function and functions of bounded variation. Differentiability of functions, chain rule, implicit differentiation, applications. Rolle's theorem and mean value theorem, monotonic functions and the first derivative test. Convexity, Concavity and curve sketching. Taylor's expansion: - various forms of remainder after n terms and application to certain standard expansions. Higher derivatives, maxima and minima. Applications of functions of a single variable: Applied optimization problems. Intermediate forms and L'Hospital's rule and other applications.
Unit – 2	Sequences, limit of a sequence, convergent sequences; bounded and monotonic sequences, the limit superior and limit inferior of a sequence. Cauchy sequences and the completeness of R, algebra of limits. Series: - convergence and divergence of series of positive terms, absolute and conditional convergence. Various tests of convergence.
Unit – 3	Riemann integration, existence of Riemann integral for sufficiently well-behaved functions. Fundamental theorem of integral Calculus, Improper integrals, Beta function, Gamma functions and related definite integrals. Surface area and Volume.

Text Books
1. W. Rudin: *Principles of Mathematical Analysis*, 3rd edition, Tata McGraw Hill, 1976. 2. T. M. Apostol: *Mathematical Analysis*, 2nd edition, Narosa, 1974. 3. R.G. Bartle, D.R. Sherbert: Introduction to Real Analysis, 3rd edition, Wiley, 2000. 4. M. D. Weir, J. Hass and F. R. Giordano: *Thomas' Calculus*, 15th edition, Pearson, 2022. 5. T. M. Apostol: *Calculus, Volumes 1 and 2*, 2nd edition, Wiley, 1980. 6. J. Stewart: *Calculus*, 5th edition, Thomson, 2003.
Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 011030	**Linear Algebra**	**Major**	L	2	T	0	P	0	2
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The goal of the course is to learn the matrix and vector algebra notation, matrix algebra operations. The study of linearly dependent and independent of vectors to understand the linear span and the basis of vector space. The study of linear transformation to understand the Eigenvalues and Eigenvectors of matrices.

Course Outcomes (COs): After completion of this course, the students shall be able to:

1. To apply linear algebra to solve system of linear equations and system of linear differential equations.
2. They will learn to find orthogonal vectors, bases, dimensions of matrices and linear operators.
3. They will learn how to find Eigen values and Eigenvectors of matrices and linear operators and study their nature.
4. To deal with analytical techniques to solve linear system that is essential in most branches of engineering.
5. To use the essential tool of matrices and linear algebra in a comprehensive manner.

Unit – 1	Vectors in R^n and C^n, notions of linear dependence and independence, linear span of a set of vectors, vector subspaces of R^n and C^n, the basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix.
Unit – 2	Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product in Euclidean space. Eigenvalues and eigenvectors, characteristic polynomials, diagonalisation, Caley-Hamilton theorem, the eigenvalue of special matrices (symmetric, skew-symmetric Hermitian, skew- Hermitian, orthogonal, unitary, normal).
Text Books	
1. E. Kreyszig: *Advanced Engineering Mathematics*, 10th edition, Wiley, 2011. **2.** G. Strang: *Linear Algebra and its Applications*, 4th edition, Thomson, 2006. **3.** H. Anton and C. Rorres: *Elementary Linear Algebra with Applications*, 11th edition, Wiley, 2016.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 021010	**Analysis and Linear Algebra**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods:	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: The goal of the course is to learn the matrix and vector algebra notation, matrix algebra operations. The study of linearly dependent and independent of vectors to understand the linear span and basis of vector space, the study of linear transformation to understand the Eigenvalues and Eigenvectors of matrices.									

Course Outcomes (Cos): Linear algebra provides the solution of systems of linear/linear differential equations. Linear algebra is also used in analytic geometry, engineering, physics, natural sciences, computer science, computer animation, economics and the social sciences. The concepts of linear algebra are crucial for understanding the theory behind machine learning, especially for deep learning. They give you better intuition for how algorithms really work under the hood, which enables you to make better decisions.

The students will learn:

- To apply linear algebra to solve system of linear equations and system of linear differential equations.
- They will learn to find orthogonal vectors, bases, dimensions of matrices and linear operators.
- They will learn how to find Eigenvalues and eigenvectors of matrices and linear operators and study their nature.
- To deal with analytical techniques to solve linear system that is essential in most branches of engineering.
- To use the essential tool of matrices and linear algebra in a comprehensive manner.

Unit – 1	The language of sets and functions. Calculus of functions of a single variable- Rates of change and limits, types of limits and asymptotes, continuity; attainment of supremum and infimum of a continuous function on a closed bounded interval, uniform continuity, absolutely continuous function and functions of bounded variation. Differentiability of functions, chain rule, implicit differentiation, applications. Rolle's theorem and mean value theorem, monotonic functions and the first derivative test. Convexity, Concavity and curve sketching. Taylor's expansion: - various forms of remainder after n terms and application to certain standard expansions. Higher derivatives, maxima and minima. Applications of functions of a single variable: Applied optimization problems. Intermediate forms and L'Hospital's rule and other applications.
Unit – 2	Sequences, limit of a sequence, convergent sequences; bounded and monotonic sequences, the limit superior and limit inferior of a sequence. Cauchy sequences and the completeness of R, algebra of limits. Series: - convergence and divergence of series of positive terms, absolute and conditional convergence. Various tests of convergence. Riemann integration, existence of Riemann integral for sufficiently well-behaved functions. Fundamental theorem of integral Calculus, Improper integrals, Beta function, Gamma functions and related definite integrals. Surface area and Volume.
Unit – 3	Vectors in R^n and C^n, notions of linear dependence and independence, linear span of a set of vectors, vector subspaces of R^n and C^n, the basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix.
Unit – 4	Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product in Euclidean

	space. Eigenvalues and eigenvectors, characteristic polynomials, diagonalisation, Caley-Hamilton theorem, the Eigenvalue of special matrices (symmetric, skew-symmetric Hermitian, skew- Hermitian, orthogonal, unitary, normal).

Text Books

1. E. Kreyszig: *Advanced Engineering Mathematics*, 10th edition, Wiley, 2011.
2. G. Strang: *Linear Algebra and its Applications*, 4th edition, Thomson, 2006.
3. H. Anton and C. Rorres: *Elementary Linear Algebra with Applications*, 11th edition, Wiley, 2016.
4. W. Rudin: *Principles of Mathematical Analysis*, 3rd edition, Tata McGraw Hill, 1976.
5. R.G. Bartle, D.R. Sherbert: Introduction to Real Analysis, 3rd edition, Wiley, 2000.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT011020	**Differential Equations-I**	**Major**	L	2	T	1	P	0	3

Pre-requisite :	
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)
Syllabus Version :	01

Course Objectives: The aim goal of this course is to learn the formation of ODE, the order and degree of ODE, known methods to solve first-order ODE, and initial and boundary value problems for first and second-order ODE. Test the ODE has the unique solution by Picard's existence and uniqueness theorem. Further, Wronskian of functions, reduction order, solution Linear equations with constant coefficients by the method of undetermined coefficients, Linear equations with variable coefficients by variation of parameters, and Euler-Cauchy equation. Further we learn Series solutions of ODE: ordinary points, power series solution, regular singular points, Frobenius method. Laplace transform definition, existence, first shifting theorem, second shifting theorem, convolution, and applications.

Course Outcomes (COs): Solution of some special classes of first-order ODEs; separable equations, homogeneous and exact ODE, integrating factors first order linear ODE, Bernoulli equation, finds the orthogonal and oblique trajectories. Students are also able to solve linear second-order ode with constant and variable coefficients and use Laplace transform to solve initial value problems.

Unit – 1	Basic concepts, Geometric meaning, Direction fields. 1st order linear equations, homogeneous and non- homogeneous, Separation of variables, Exact Differential equations, integrating factors, Bernoulli Equation, Orthogonal trajectories, Existence Uniqueness: Picard's iteration, Autonomous Differential Equations and Population Dynamics. Nonlinear first order differential equations and their solutions.
Unit – 2	2nd and higher order Linear Differential equations: homogeneous and non-homogeneous equation with constant coefficients, Mass spring system, Wronskian, method of undetermined coefficients, operator method, variation of parameters method, Mechanical and Electrical Vibrations, Forced Periodic Vibrations, Euler's equation, Systems of first order differential equations, Trial solution method for linear system with constant coefficients and Eigen value technique. Particular solution.
Unit – 3	Laplace transforms generalities, Shifting theorems, Convolution theorem. Application to finding solution of initial value problem, integral equations and other applications, Step Functions, Differential Equations with Discontinuous Forcing Functions, Impulse Functions.
Text Books	
1. E. Kreyszig: *Advanced Engineering Mathematics*, 10th edition, Wiley, 2011. **2.** William E. Boyce, Richard C. DiPrima, Douglas B. Meade: *Elementary Differential Equations and Boundary Value Problems*, 12th edition, Wiley, 2021. **3.** T.M. Apostol: *Calculus*, Volume II, 2nd edition, Wiley, 1980.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT011040	**Group Theory**	**Major**	L	2	T	0	P	0	2
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The main aim of the course is to introduce basic concepts of abstract algebra, especially the notion of a group. The course will help us to prepare for further study in abstract algebra and many other areas of mathematics. Group theory is one of the great simplifying and unifying ideas in modern mathematics. It plays a major role in our understanding of fundamental particles, the structure of crystal lattices, and the geometry of molecules.	
Course Outcomes (COs): At the end of the course students are able to understand the concept of algebraic structures, groups, rings, fields, modules, etc. Students are also able to understand concepts of abelian, symmetric, cyclic, quotient, normal, Sylow groups, homomorphism, isomorphism, and their properties. Further, students can understand the integral domain, zero divisors, division ring, ring homomorphism, and field.	
Unit – 1	Semigroups, Groups, Homomorphisms, Subgroups, Permutation Groups, Normal Subgroups, Isomorphism Theorem, Automorphisms, Conjugacy and G-sets.
Unit – 2	Normal Series, Solvable groups, Nilpotent groups, Cyclic decomposition of permutations, Alternating group. Structure Theorem of Finite abelian groups. Sylows theorems, groups of orders p^2, pq.
Text Books	
1. P.B. Bhattacharya, S. K. Jain and S. R. Nagpaul: Basic Abstract Algebra, 2nd edition, Cambridge University Press, 1995. **2.** J. A. Gallian: Contemporary Abstract Algebra, 4th edition, Narosa, 1998. **3.** D. S. Dummit and R. M. Foote: Abstract Algebra, 2nd edition, Wiley, 1999. **4.** I. N. Herstein: Topics in Algebra, 2nd edition, Wiley, 1975.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT021020	**Differential Equations-I**	**Minor**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: The aim goal of this course is to learn the formation of ODE, the order and degree of ODE, known methods to solve first-order ODE, and initial and boundary value problems									

for first and second-order ODE. Test the ODE has the unique solution by Picard's existence and uniqueness theorem. Further, Wronskian of functions, reduction order, solution Linear equations with constant coefficients by the method of undetermined coefficients, Linear equations with variable coefficients by variation of parameters, and Euler-Cauchy equation. Laplace transform definition, existence, first shifting theorem, second shifting theorem, convolution, and applications.

Course Outcomes (COs): Solution of some special classes of first-order ODEs; separable equations, homogeneous and exact ODE, integrating factors first order linear ODE, Bernoulli equation, find the orthogonal and oblique trajectories. Students are also able to solve linear second-order ode with constant and variable coefficients and use Laplace transform to solve initial value problems.

Unit – 1	Basic concepts, Geometric meaning, Direction fields. 1st order linear equations, homogeneous and non- homogeneous, Solution Method for Nonlinear equations, Separation of variables, Exact Differential equations, integrating factors, Bernoulli Equation, Orthogonal trajectories, Existence Uniqueness: Picard's iteration, nonlinear first order differential equation.
Unit – 2	2nd and higher order Linear Differential equations: homogeneous and non-homogeneous equation with constant coefficients, Mass spring system, Wronskian, method of undetermined coefficients, operator method, variation of parameters method, Euler's equation.
Unit – 3	Systems of first order differential equations, Trial solution method for linear system with constant coefficients and Eigen value technique. Particular solution.
Unit – 4	Laplace transform generalities, Shifting theorems, Convolution theorem. Solution of Improper integrals. Application to finding solution of initial value problem, integral equations and other applications.

Text Books

1. E. Kreyszig: *Advanced Engineering Mathematics*, 9th edition, Wiley, 2005.
2. W. E. Boyce and R. C. DiPrima: *Elementary Differential Equation*, 8th edition, Wiley, 2005.
3. T.M. Apostol: *Calculus*, Volume II, 2nd edition, Wiley, 1980.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 031020	**Mathematics In Daily Life**	**Multi-Disciplinary**	L	3	T	0	P	0	3

		Course							
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: To introduce the basic mathematical concepts that are used in different aspects of our daily life.									
Course Outcomes (COs): After this course students will be able to understand everyday banking transactions, identify patterns and relationships. Students will be able to perform basic calculations and measurement and also understand about ratios and proportions. Notes: A candidate must obtain the minimum pass marks to clear the course.									
Unit – 1	**Arithmetical Ability** Unit conversion (length, mass, time); Number System; Decimal Fractions; Square Roots and Cube Roots; Problems on Numbers; Problems on Ages; Use of concepts of HCF and LCM; Percentage; Ratio and Proportion; Time and Distance; Alligations or Mixture; Area, Volume, Surface Areas; Trigonometric ratios; Height and Distance in our everyday life.								
Unit – 2	**Banking Ability** Interest - Concept of Present value and Future value, Simple interest, Compound interest, Nominal and Effective rate of interest; Depreciation and discount; Annuity - Ordinary annuity, sinking fund, annuity due, present value and future value of annuity; Equated Monthly Installments (EMI) by Interest of Reducing Balance and Flat Interest methods - examples and problems.								
Unit – 3	**Data Interpretation** Probability; Classification of data - Frequency distribution, Tabulation; Graphical representation of data - Bar Graphs, Pie Charts, Line Graphs; Calendar and Clocks.								
Text Books									
1. R.S. Agrawal, Quantitative Aptitude, S. Chand Publishing (2022). **2.** M.K. Bhowal, Fundamentals of Business Mathematics, Asian Books (2009). **3.** S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Publishing (2020). **4.** A.S. Posamentier, C. Spreitzer, The Mathematics of Everyday Life, Prometheus Books, Illustrated Edition (2018).									
Reference Books:									

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 051020	**Quantitative Aptitude and Logical Thinking**	**Skill Enhancement Course**	L	3	T	0	P	0	3
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: Quantitative and logical thinking are crucial skills that involve the ability to analyse, interpret, and manipulate numerical and logical information.

1. To introduce the basic mathematical concepts that are used in different aspects of our daily life.
2. Apply quantitative and logical reasoning to solve problems in different contexts.

Course Outcomes (COs): After this course students will Identify and define problems that require quantitative and logical analysis. Apply systematic problem-solving strategies to arrive at solutions. Demonstrate proficiency in basic mathematical concepts and operations. Apply mathematical and statistical techniques to analyze and interpret data. Develop skills in deductive and inductive reasoning.

Unit – 1	**Quantitative Aptitude & Data Interpretation** Unit – 1: Whole numbers, Integers, Rational and irrational numbers, Fractions, Square roots and Cube roots, Surds and Indices, Problems on Numbers, Divisibility, Steps of Long Division Method for Finding Square Roots: Numerical computations based on 16 sutras and 13 sub-sutras of Vedic mathematics. Unit -2: Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture Unit- 3: Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and

	Speed ; relationship among them Unit – 4: Concept of Angles, Different Polygons like triangles, rectangle, square, right angled triangle, Pythagorean Theorem, Perimeter and Area of Triangles, Rectangles, Circles Unit – 5: Raw and Grouped Data, Bar Graphs, Pie charts, Mean, Median and Mode, Events and Sample Space, Probability.
Unit – 2	**LOGICAL REASONING** Unit - 1: Analogy basing on kinds of relationships, Simple Analogy; Pattern and Series of Numbers, Letters, Figures. Coding-Decoding of Numbers, Letters, Symbols (Figures), Blood relations. UNIT – 2: Logical Statements – Two premise argument, More than two premise argument using connectives UNIT -3: Venn Diagrams, Mirror Images, Problems on Cubes and Dices
Text Books	
1. R.S. Aggarwal, Quantitative Aptitude, S. Chand Publishing (2022). **2.** Disha Experts, Shortcuts in Quantitative aptitude for competitive exams, 3rd Edition, Disha Publication, 2021 **3.** R. V. Praveen, Quantitative Aptitude and Reasoning, PHI, 2012. **4.** Ramnandan Shastri, Vedic Mathematics For All Competitive Exams, Arihant, 2012.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 012010	**Probability-I**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The course covers fundamental concepts and basic examples, assuming no previous knowledge of the subject. But required some knowledge of calculus, basic combinatorics, and set theory is assumed. Also, this is a preparatory course in basic probability theory for the next-level course in Statistical methods that are useful for everyday life. Therefore the students can choose this course for their careers.

Course Outcomes (COs): After completing this course students acquire a basic knowledge of Probability Theory, useful for modeling uncertain phenomena, and required an understanding the logic of Statistical Methods and machine learning. Also acquire a basic understanding of random variables, random vectors, and discrete-valued random processes. Thus students will be able to understand advanced probability models and be able to analyze and develop such models.

Unit – 1	An Introduction to Probability: Introduction, A Review of Sets, Sigma Fields, Experiments and Sample Spaces, Events, Definitions of Probability, Finite Sample Spaces and Enumeration, Conditional Probability, Addition and Multiplication Theorems, Independent Events, Total Probability, Bayes Theorem.
Unit – 2	One Dimensional Random Variables: Introduction, Discrete and Continuous Random Variables, Distribution Function, Probability Mass and Density Functions. Functions of One Random Variable and Expectation: Introduction, Functions of Discrete Random Variable, Continuous Function of Continuous Random Variable, Expectation, Probability Generating Function, Moment Generating Function, Characteristic Function.
Unit – 3	Joint Probability Distributions: Introduction, Joint Distribution for two Dimensional Random Variables, Marginal Distributions, Conditional Distributions, Covariance, Conditional Expectation, Independence of Random Variables, The Distribution Function for two Dimensional Random Variables. Distribution of Sum of two Independent Random Variables. Basic Properties of Some Important Distributions: Degenerate, Bernoulli, Binomial, Negative Binomial, Geometric, Hyper-Geometric, Poisson, Multinomial, Pascal, Uniform, Exponential, Gamma, Weibull, Normal.

Text Books

1. K.L. Chung and F. Aitsahlia: Elementary Probability Theory: with Stochastic Process and an Introduction to Mathematical Finance, *Springer*, *4th Edition, 2003.*
2. W.W. Hines, D.C. Montgomery, D.M. Goldsman, and C.M. Borror: Probability and Statistics in Engineering, *John Wiley and Sons, 4th Edition, 2007.*
3. S.M. Ross: Introduction to Probability and Statistics for Engineers and Scientists, *Academic Press, 4th Edition, 2010.*
4. P. Billingsley: Probability and Measure, *Wiley, 3rd Edition, 2012.*
5. W. Feller: An Introduction to Probability Theory and its Applications, Vol-I, *Wiley India, 3rd edition, 2008.*
6. W. Feller: An Introduction to Probability Theory and its Applications, Vol-II, *Wiley India, 2nd edition, 2008.*
7. S. C. Gupta and V. K. Kapoor: *Fundamental of Mathematical Statistics*, S. Chand, 2007.
8. A. M. Goon, M. K. Gupta, B. Dasgupta: *Fundamental of Statistics*, Vol. I, II, World Press,

2001.
Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 011030	**Calculus**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The goal of the course is to learn basic techniques of differentiation and integration, the students gain some proficiency in calculus computation, and they use some main tools for analysing the behaviour of functions: limits, derivatives and integral. Students can use these tools to handle application problems in physics, biology, business and economics.

Course Outcomes (COs): Students are able to understand basic Calculus concepts, including differentiation and integration techniques, convergence of integrals and infinite series, and Taylor's theorem. Students can apply the knowledge of the above concepts to exhibit algebraically and geometrically. Further Calculus concepts will be applied to solve physics, geometry, and numerical approximation problems.

The students will learn:

- To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- To explain the fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- To discuss the tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that is essential in most branches of engineering.

Unit – 1	**Calculus:** (Quick review of Successive differentiation and Leibnitz theorem, limits, continuity, and differentiability, Mean value theorem, Taylors Theorem, Maxima and Minima). Riemann integration, Darboux theorem, Fundamental theorem of integral Calculus, Improper integrals, Beta function, Gamma functions and related

	definite integrals. Surface area and Volume. Convergence of sequences and series, power series.
Unit – 2	Calculus of several variables differentiability of maps from R^m to R^n and the derivative as a linear map. Higher derivatives, Chain Rule, Taylor expansions in several variables, Local Maxima and minima, Lagrange multiplier.
Unit – 3	Multiple integrals, Existence of the Riemann integral for sufficiently well behaved functions on rectangles, i.e. product of intervals. Multiple integrals expressed as iterated simple integrals. Brief treatment of multiple integrals on more general domains. Change of variables and the Jacobian formula. Inverse and implicit function theorems.
Unit – 4	More advanced topics in the calculus of one and several variables- curves in R^2 and R^3. Line integrals, Surfaces in R^3, Surface integrals, Divergence, Gradient and Curl operations, Green's, Strokes' and Gauss' (Divergence) theorems.

Text Books

1. George B. Thomas, Joel Hass, Christopher Heil, Maurice D. Weir: *Thomas' Calculus*, 14th edition, Pearson, 2018.
2. E. Kreyszig: *Advanced Engineering Mathematics*, 10th edition, Wiley, 2011.
3. T. M. Apostol: *Calculus, Volumes 1 and 2*, 2nd edition, Wiley, 1980.
4. J. Stewart: *Calculus*, 9th edition, Thomson, 2021.
5. S. Narayan: A Textbook of Vector Calculus, S. Chand, 2003.
6. W. Rudin: *Principles of Mathematical Analysis*, 3rd edition, McGraw Hill 1976
7. W. Fleming: *Functions of Several Variables*, 2nd edition, Springer Verlag, 1977.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 022010	**Calculus**	**Minor**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The goal of the course is to learn basic techniques of differentiation and integration, the students gain some proficiency in calculus computation, and they use some main tools for analysing the behaviour of functions: limits, derivatives and integral. Students can use these tools to handle application problems in physics, biology, business and economics.

Course Outcomes (COs): Students are able to understand basic Calculus concepts, including differentiation and integration techniques, convergence of integrals and infinite series, and Taylor's theorem. Students can apply the knowledge of the above concepts to exhibit algebraically and geometrically. Further Calculus concepts will be applied to solve physics, geometry, and numerical approximation problems.

The students will learn:

- To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- To explain the fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- To discuss the tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that is essential in most branches of engineering.

Unit – 1	Calculus: (Quick review of Successive differentiation and Leibnitz theorem, limits, continuity, and differentiability, Mean value theorem, Taylors Theorem, Maxima and Minima). Riemann integration, Darboux theorem, Fundamental theorem of integral Calculus, Improper integrals, Beta function, Gamma functions and related definite integrals. Surface area and Volume. Convergence of sequences and series, power series.
Unit – 2	Calculus of several variables differentiability of maps from R^m to R^n and the derivative as a linear map. Higher derivatives, Chain Rule, Taylor expansions in several variables, Local Maxima and minima, Lagrange multiplier.
Unit – 3	Multiple integrals, Existence of the Riemann integral for sufficiently well behaved functions on rectangles, i.e. product of intervals. Multiple integrals expressed as iterated simple integrals. Brief treatment of multiple integrals on more general domains. Change of variables and the Jacobian formula. Inverse and implicit function theorems.
Unit – 4	More advanced topics in the calculus of one and several variables- curves in R^2 and R^3. Line integrals, Surfaces in R^3, Surface integrals, Divergence, Gradient and Curl operations, Green's, Strokes' and Gauss' (Divergence) theorems.

Text Books

1. George B. Thomas, Joel Hass, Christopher Heil, Maurice D. Weir: *Thomas' Calculus*, 14th edition, Pearson, 2018.
2. E. Kreyszig: *Advanced Engineering Mathematics*, 10th edition, Wiley, 2011.
3. T. M. Apostol: *Calculus, Volumes 1 and 2*, 2nd edition, Wiley, 1980.
4. J. Stewart: *Calculus*, 9th edition, Thomson, 2021.

5. S. Narayan: A Textbook of Vector Calculus, S. Chand, 2003.
6. W. Rudin: *Principles of Mathematical Analysis*, 3rd edition, McGraw Hill 1976
7. W. Fleming: *Functions of Several Variables*, 2nd edition, Springer Verlag, 1977.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 012020	**Statistics-I**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The general goal of this course is to study Introduction to Statistics, different measurement scales, and various types of data, to analyze and interpret data, to organize data into frequency distribution graphs, including bar graphs, histograms, polygons, and Ogives, Students will confer the measuring central tendency, dispersion, skewness, kurtosis and compute them as well to understand the concept of moments and attributes. the concepts of probability, its applications, the concept of random variables, probability functions, expectation and generating functions, properties of random variables like expectation, moment generating function, cumulative generating function etc., introduction to p.m.f, p.d.f and c.d.f.

Course Outcomes (COs): At the end of this course students may able to understand the concept of a statistical population and a sample from a Population. Measures of central tendency, Dispersion, Skewness and Kurtosis and Moments. They can also understand the concept of correlation, correlation coefficients - Karl Pearson's correlation coefficient, Spearman's rank correlation coefficient, multiple and partial correlation coefficients, and Intraclass correlation. The students gain knowledge on random variables and are able to distinguish which are discrete and continuous random variables. Probability mass function and probability density function. Mathematical expectation of a random variable. Conditional expectation and variance. Gain knowledge in sampling distribution theory and their applications in statistical inference. Chi- square, t and F distribution.

Unit – 1	Basic Concepts of Statistics: Introduction, Applications of Statistics in Science, Population, Variable, Parameter, Sample, Brief idea on Sampling Theory.
Unit – 2	Collection and Representation of Data: Introduction, Collection of Raw Data,

	Category of Raw Data, Organization of Data, Tabular and Graphical Methods for Describing Data.
Unit – 3	Summarizing the Dataset: Introduction, Grouped and Ungrouped Dataset, Measures of Central Tendency, Measures of Dispersion, Coefficient of Variation, Raw and Central Moments, Skewness and Kurtosis.
Unit – 4	Correlation and Regression Analysis: Introduction, Types of Correlation, Karl Pearson's Coefficient of Correlation, Properties, Rank Correlation, Multiple and Partial Correlation, Linear Regression Model, Regression Coefficient and its Properties, Computation of Regression Equation, Multiple Regression Analysis.
Unit – 5	Sampling Distributions: Sampling Distribution based on Normal Random Variables, t- Distribution, Chi-Square Distribution, F Distribution, Non-Central Chi- Square, t and F Distributions. Sampling from Bivariate Normal Distribution.

Text Books

1. S. Sarkar and N. Pal: Statistics- Concepts and Application, Prentice Hall of India Private Limited, 2nd Edition, 2008.
2. G. Casella and R. L. Berger: Statistical Inference, Cengage Learning, 3 rd Edition, 2008.
3. W.W. Hines, D.C. Montgomery, D.M. Goldsman, and C.M. Borror: Probability and Statistics in Engineering, John wiley and Sons, 4 th Edition, 2007.
4. R.E. Walpole, R.H. Myers, S.L. Myers and K. Ye: Probability and Statistics, Pearson Education, 2006.
5. S. C. Gupta and V. K. Kapoor: Fundamental of Mathematical Statistics, S. Chand, 2007.
6. A. M. Goon, M. K. Gupta, B. Dasgupta: Fundamental of Statistics, Vol. I, II, World Press, 2001.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 012040	**Partial Differential Equation-I**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								

Syllabus Version :	01

Course Objectives: The main aim of this course is to give an introduction to the basic properties of PDEs and to the basic analytical techniques to solve PDEs equations. A partial differential equation (PDE) is a differential equation that must contain an unknown function and its partial derivatives. PDEs also play an important role in other areas of mathematics such as analysis and differential geometry.

Course Outcomes (COs): After completion of this course students should able to solve the simplest first-order PDEs and recognize the type of second-order PDEs. Further students able to understand what are well-posed initial or boundary value problems for classical PDEs such as the wave equation, the Laplace equation, and the heat (diffusion) equation.

Unit – 1	Introduction to partial differential equations. Solution of linear and nonlinear partial differential equations of order one. Introduction to Cauchy's problem. Homogeneous and non-homogeneous linear partial differential equations. Classification of partial differential equations, reduction to canonical or normal form. Monge's method, second order Cauchy Problem.
Unit – 2	Sturm–Liouville problems and eigenfunction expansions: The Sturm–Liouville problem, Inner product spaces and orthonormal systems, basic properties of Sturm–Liouville eigenfunctions and eigenvalues, Nonhomogeneous equations, Nonhomogeneous boundary conditions.
Unit – 3	Elements of Fourier analysis: The Fourier series of a function, convergence of Fourier series, Fourier Integral, Fourier transform and their convergence.

Text Books

1. P.V. O'Neil: Beginning Partial Differential Equations, 2nd edition, Wiley, 2008.
2. Y. Pinchover and J. Rubinstein: An Introduction to Partial Differential Equations, Cambridge University Press, 2005.
3. R. Haberman: Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, 4th edition, Pearson, 2004.
4. M. D. Raisinghania: Ordinary and Partial Differential Equations, 12 th edition, S. Chand, 2010.
5. R. P. Agarwal and D. O'Regan: Ordinary and Partial Differential Equations. With Special Functions, Fourier Series, Boundary Value Problems, Springer 2009.
6. L.C. Evans: Partial Differential Equations, AMS, 1998.
7. E. A. Coddington and N. Levinson: Theory of Ordinary Differential Equations, Tata McGraw Hill, 1987.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 012060	**Number Theory**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The course aims to give elementary ideas of number theory which will have applications in cryptography. Reader Identify and apply various properties of and relating to the integers including the Well-Ordering Principle, primes, unique factorization, and the division algorithm, and understand the concept of quadratic congruence. Prime power module and primitive roots may help to improve the existing algorithm for primality testing and prime factorization problem which is highly applicable in coding theory and cryptography to develop new digital devices. This course also covers Euler's, Lagrange and Wilson theorem, Euler criterion, Legendre symbol, Law of quadratic reciprocity; neither Euler nor Legendre were able to prove this but Gauss, Pell's equation.

Course Outcomes (COs): After completing the course, students will be able to solve elementary number theory problems they can apply elementary number theory to cryptography. Develop a deeper conceptual understanding of the theoretical basis of number theory and identify how number theory is related to and used in cryptography.

Unit – 1	Divisibilty, division algorithm, Euclidean Algorithm, Algebraic congruences of higher degree. General Taylor Expansion Method for Prime Power Modulus Theorems of Euler, Lagrange and Wilson. Primality Testing and Factoring, Primitive Roots.
Unit – 2	Quadratic Congruence, Euler's Criteria and Legendre's Symbol, two square theorem, quadratic reciprocity law, Arithmetic function, Dirichlet product, Mobius inversion formula, divisor function.
Unit – 3	Simple continued fractions, Approximation to rational numbers, Hurwitz theorem, periodic continued fraction, Pell's Equation.

Text Books

1. G.H. Hardy and E.M. Wright: An Introduction to The Theory of Numbers, 6 th edition, Oxford University Press, 2008.
2. D.M. Burton: Elementary Number Theory, 6 th edition, McGraw-Hill, 2005.
3. I. Niven, H.S. Zuckerman and H.L. Montgomery: An Introduction to The Theory of Numbers, 5 th edition, Wiley, 1991.

4. T. M. Apostol: Introduction to Analytic Number theory, Springer-Verlag 1976

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 012080	**Optimization Techniques-I**	**Major**	L	2	T	0	P	0	2

Pre-requisite	:
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)
Syllabus Version :	01

Course Objectives: linear Programming deals with the problem of optimizing a linear objective function subject to linear equality and inequality constraints on the decision variables. Linear programming has many practical applications (e.g. assignment problems, transportation, problems, production planning problem, etc). One aspect of linear programming which is often forgotten is the fact that it is also a useful proof technique. In the beginning chapter, we study some linear programming formulations for some classical problems. We also show that linear programs can be expressed in a variety of equivalent ways.

Course Outcomes (COs): After completion of this course students are able to maximize (or, minimize) profit (or, cost) of a general class of problems called optimization problems by using Graphical, the Simplex, Dual Simplex, Two Phase, Big-M method. Further students can able to minimize transportation costs by using, the North-West corner rule, Least-Cost, and Vogel's approximation method.

Unit – 1	Introduction to Operation Research: Operations research techniques, simulation models. Convex Sets and Convex functions. Linear Programming formulation and graphical solution: Models of mathematical operations research, art of modeling, construction of the LP model, graphical LP solution. The Simplex method: Standard LP form, basic solution, The Simplex method, the M-method, the two-phase method, degeneracy, alternative optimal solution, unbounded solution, infeasible solution, the dual Simplex method.
Unit – 2	Sensitivity analysis and dual problem: Definition of the dual problem, the relationship between the optimal primal and dual solution, economic interpretation

	of duality, primal-dual computations, sensitivity analysis. Transportation, assignment and transshipment models: Definition of the transportation model, determination of a starting solution, the transportation algorithm, definition of the assignment problem, the Hungarian method, the transhipment model.
Text Books	
1. H. A. Taha: Operations Research: An introduction, 8th edition, Pearson, 2008. 2. F. Hillier and G. Liebermann: Introduction to Operations Research, 8th edition, McGraw Hill, 2005. 3. W. L. Winston: Operations Research: Applications and Algorithms, 4th edition, Cengage, 2004. 4. S. D. Sharma: Operations Research: Theory and Applications, 4th edition, Macmillan, 2010. 5. J. K. Sharma: Operations Research: Theory and Applications, 4th edition, Macmillan, 2009.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 013010	**Numerical Analysis with Lab-I**	**Major**	L	3	T	0	P	1	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: This course covers: the mathematical and computational foundations of the numerical approximation and solution of scientific problems; simple optimization; vectorization; clustering; polynomial and spline interpolation; pattern recognition; integration and differentiation; solution of large-scale systems of linear and nonlinear equations; modeling and solution with sparse equations; explicit schemes to solve ordinary differential equations.									
Course Outcomes (COs): Demonstrate an understanding of common numerical methods and how they are used to obtain approximate solutions to mathematical problems. Apply numerical methods to obtain approximate solutions to mathematical problems. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of									

linear and nonlinear equations, and the solution of differential equations. Analyse and evaluate the accuracy of common numerical methods. Implement numerical methods in Matlab. Write efficient, well-documented Matlab code and present numerical results in an informative way.	
Unit – 1	**Nature of numerical computations:** errors and their propagation, convergence and stability of numerical algorithms; efficiency and arithmetic, complexity.
Unit – 2	**Numerical solution of systems of linear equations:** Direct methods for solving linear systems, error analysis. The residual correction method. Iteration methods, Error prediction and Acceleration.
Unit – 3	**Matrix Eigenvalue problem:** Eigenvalue location, error, and stability results, Power method. Orthogonal transformations using Householder matrices. The eigenvalues of a symmetric Tridiagonal matrix. QR method. The calculation of Eigenvectors and Inverse iteration.
Unit – 4	**Numerical solutions of Non-linear equations:** Solution of non-linear equations by iterative methods, acceleration of convergence. Newton's methods for polynomials, quotient-difference algorithms. Numerical solution of system of Non-linear equations.
Unit – 5	**Interpolation:** Interpolating polynomial and its construction using Lagrange methods and methods of differences, iterated interpolation, method of divided differences, inverse interpolation, Hermite Interpolation. The general Hermite interpolation problem. Spline function and their use.
Unit – 6	**Lab Component:** Exposure to Matlab/Mathematica and computational experiments based on the algorithms discussed in the course.
Text Books	
1. K. Atkinson: An Introduction to Numerical Analysis, 2nd edition, Wiley, 1989. **2.** R.L. Burden and J.D. Faires: Numerical analysis, 7th edition, Brooks Cole, 2001. **3.** P.J. Davis: Interpolation and Approximation, Dover, 1975. **4.** J.M. Ortega: Numerical Analysis: A Second Course, SIAM, 1987. **5.** S.S. Sastry: Introductory Methods of Numerical Analysis, Phi Learning, 2009.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours	Credit

MAT 013030	Complex Analysis	Major	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: This course covers fundamental knowledge of complex numbers including the theory of analytical functions. This course also covers the knowledge of limits and continuity for complex functions as well as the consequences of continuity. Further, this course has applications to find definite integration with the study of harmonic and special functions. The complex functions make a significant contribution to the understanding of the world in which we live.

Course Outcomes (COs): After successful completion of the course, students will be able to: Calculate series expansions for analytical complex-valued functions and evaluate contour integrals in the complex plane. Evaluate complex contour integrals directly, by the fundamental theorem, by applying the Cauchy integral theorem, and the Cauchy integral formula. Students may be able to represent complex functions as a Taylor, power, and Laurent series, and they classify singularities and poles, also able to find residues and evaluate complex integrals using the residue theorem.

Unit – 1	Basic algebraic properties of complex numbers, Exponential form, Roots of complex numbers. Functions of a complex variable, mappings, Cauchy-Riemann equations, sufficient conditions for differentiability, Analytic functions, Harmonic functions. Elementary functions: The exponential, logarithm functions, branches and derivatives of logarithms. Complex exponents, trigonometric, hyperbolic functions and their inverses.
Unit – 2	Integrals: Complex integrals, Upper bounds for moduli of contour integrals, Cauchy's theorem, Cauchy's integral formula, Liouvilles' theorem and fundamental theorem of algebra, maximum modulis principle. Series: Classification of singularities. Representations of holomorphic functions in terms of power series, Meromorphic functions, zeros and poles, Laurent expansions. Residues and Poles: poles and zeroes, Cauchy's residue theorem, Residue at infinity, Residue at poles. Evaluation of improper integrals and definite integrals using contour integration. Argument principle and Rouche's theorem.
Unit – 3	Mapping by Elementary functions: Linear transformations, linear fractional transformations, other mappings by elementary functions. Conformal mapping: Preservation of angles, transformations of harmonic functions and boundary conditions. Applications of conformal mappings.

Text Books

1. R. V. Churchill and J. W. Brown: Complex Variables and Applications, 8th edition, McGraw Hill, 2009.
2. L. Ahlfors: Complex Analysis: an Introduction to the Theory of Analytic Functions of One Complex Variable, 3rd edition, Tata McGraw Hill, 1979.

3. E.T. Copson: Theory of Functions of a Complex Variable, Oxford University Press, 1970.
4. J.B. Conway: Functions of One Complex Variable, 2nd edition, Narosa, 1973.
5. D. Sarason: Complex Function Theory, 2nd edition, Hindustan Publishing Company, 2008.
6. M.J. Ablowitz: Complex Variables Introduction and Applications, 2nd edition, Cambridge University Press, 2003.
7. S. Ponnusamy and H. Silverman: Complex Variables with Applications, Birkh¨auser, 2006.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 013050	**Probability-II**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: Probability-I is the prerequisite of this course. This course provides an understanding of the basic concepts in the random variable, mathematical expectation, concept of convergence and check for the convergence of a given sequence of random variables. and different types of distributions, sampling theory and estimation theory.

Course Outcomes (COs):

Unit – 1	**Inequalities:** Introduction, Probability Inequalities, Hoeffding's Inequality, The Bounded Difference Inequality, Bounds on Expected Values, Chernoff Bound, Cherboff Bound and a Sumof Poisson Trials.
Unit – 2	**Properties of a Random Sample:** Introduction, Basic Concepts of Random Sample, Convergence Concepts, Convergence in Probability, Almost Sure Convergence, Convergence in Distribution, The Delta Method, Order Statistics and their Distributions..
Unit – 3	**Limit Theorems:** Introduction, Weak Law of Large Numbers, Strong Law of Large Numbers, Limiting Moment Generating Function, Kolmogorov Khinchin Theorem, Borel Cantelli Lemma, Kolmogorov Series Theorem, Central Limit

	Theorem.
Unit – 4	**Concept of Generation of Random Variables:** Introduction, Generation of Discrete and Continuous Random Variables. **Introduction to Stochastic Process:** Introduction, Purposes and Applications.
Text Books	
1. K.L. Chung and F. Aitsahlia: Elementary Probability Theory: with Stochastic Process and an Introduction to Mathematical Finance, Springer, 4th Edition, 2003. 2. P. Billingsley: Probability and Measure, Wiley, 3rd Edition, 2012. 3. S. Ross: A First course in Probability, 6th Edition, Pearson Education, 2006. 4. V.K. Rohatgi and A.K. Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley and Sons, Inc. 2003. 5. W. Feller: An Introduction to Probability Theory and its Applications, Vol-I, II, Wiley India, 3rd edition, 2008.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
	Graph Theory-I	**Elective**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: The main goal of this topic is to study Directed and undirected graphs; paths, cycles, trees, Eulerian cycles, matchings and coverings, connectivity, Menger's Theorem, network flow, coloring, planarity, with applications to the sciences.									
Course Outcomes (COs): After completion of the graph theory, students achieved command of the fundamental definitions and concepts of graph theory. Further students are familiar with the major viewpoints and goals of graph theory: classification, extremality, optimization and sharpness, algorithms, and duality. Students are able to evaluate real-world applications using graph theory.									

Unit – 1	Graphs and Sub graphs:- Graphs and simple graphs, Graph isomorphism, The incidence and adjacency matrices, sub graphs, connected and bipartite graphs, walk, trail, path and cycles.
Unit – 2	Application:- The Shortest path problem, Dijkstra algorithm, Warshall Algorithm.
Unit – 3	Trees:- Trees, Cut Edge and Bond, Cut vertex, spanning trees and Cayley's formula. The Connector Problem: Prim's Algorithm, Kruskal's Algorithm. Euler tour and Hamilton's Cycles, characterization of Eulerian graphs, a necessary and some sufficient characterizations of Hamiltonian graph. Closure and degree majorization and related results, Chinese Postman Problem.
Unit – 4	Matchings: Theorem of Berge, Matchings and coverings in Bipartite graphs, Application: Hall's marriage theorem, Some Assignment Problems.
Unit – 5	Connectivity: m-connectivity and blocks, Construction of Reliable Communication Networks.
Unit – 6	Vertex Coloring: Planar graph, Euler's formula, Chromatic Number, Brook's Theorem, 5-color theorem.
Unit – 7	**Lab Component:** Implementation in C: Dijkstra Algorithm, Warshall Algorithm, BFS, DFS, Prims Algorithm, Kruskal Algorithm, Connectivity Algorithm, Flurey Algorithm.
Text Books	
1. J.A. Bondy and U.S.R Murty: Graph Theory, Springer, 2008. **2.** F. Harary: Graph Theory, Westview Press, 1994. **3.** R.J. Wilson: Introduction to Graph Theory, 4th edition, Pearson, 2002. **4.** J. Clark and D. A. Holton: A First Look at Graph Theory, World Scientific, 1991. **5.** D.B. West: Introduction to Graph Theory, 2nd edition, PHI Learning, 2009. **6.** N. Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India, 2004.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 023010	**Numerical Analysis with Lab-I**	**Minor**	L	3	T	0	P	1	4
Pre-requisite	:								

Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)
Syllabus Version :	01

Course Objectives: This course covers: the mathematical and computational foundations of the numerical approximation and solution of scientific problems; simple optimization; vectorization; clustering; polynomial and spline interpolation; pattern recognition; integration and differentiation; solution of large-scale systems of linear and nonlinear equations; modeling and solution with sparse equations; explicit schemes to solve ordinary differential equations.

Course Outcomes (COs): Demonstrate an understanding of common numerical methods and how they are used to obtain approximate solutions to mathematical problems. Apply numerical methods to obtain approximate solutions to mathematical problems. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations. Analyse and evaluate the accuracy of common numerical methods. Implement numerical methods in Matlab. Write efficient, well-documented Matlab code and present numerical results in an informative way.

Unit – 1	**Nature of numerical computations:** errors and their propagation, convergence and stability of numerical algorithms; efficiency and arithmetic, complexity.
Unit – 2	**Numerical solution of systems of linear equations:** Direct methods for solving linear systems, error analysis. The residual correction method. Iteration methods, Error prediction and Acceleration.
Unit – 3	**Matrix Eigenvalue problem:** Eigenvalue location, error, and stability results, Power method. Orthogonal transformations using Householder matrices. The eigenvalues of a symmetric Tridiagonal matrix. QR method. The calculation of Eigenvectors and Inverse iteration.
Unit – 4	**Numerical solutions of Non-linear equations:** Solution of non-linear equations by iterative methods, acceleration of convergence. Newton's methods for polynomials, quotient-difference algorithms. Numerical solution of system of Non-linear equations.
Unit – 5	**Interpolation:** Interpolating polynomial and its construction using Lagrange methods and methods of differences, iterated interpolation, method of divided differences, inverse interpolation, Hermite Interpolation. The general Hermite interpolation problem. Spline function and their use.
Unit – 6	**Lab Component:** Exposure to Matlab/Mathematica and computational experiments based on the algorithms discussed in the course.

Text Books

1. K. Atkinson: An Introduction to Numerical Analysis, 2nd edition, Wiley, 1989.
2. R.L. Burden and J.D. Faires: Numerical analysis, 7th edition, Brooks Cole, 2001.
3. P.J. Davis: Interpolation and Approximation, Dover, 1975.
4. J.M. Ortega: Numerical Analysis: A Second Course, SIAM, 1987.
5. S.S. Sastry: Introductory Methods of Numerical Analysis, Phi Learning, 2009.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 023030	**Complex Analysis**	**Minor**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: This course covers fundamental knowledge of complex numbers including the theory of analytical functions. This course also covers the knowledge of limits and continuity for complex functions as well as the consequences of continuity. Further, this course has applications to find definite integration with the study of harmonic and special functions. The complex functions make a significant contribution to the understanding of the world in which we live									
Course Outcomes (COs): After successful completion of the course, students will be able to: Calculate series expansions for analytical complex-valued functions and evaluate contour integrals in the complex plane. Evaluate complex contour integrals directly, by the fundamental theorem, by applying the Cauchy integral theorem, and the Cauchy integral formula. Students may be able to represent complex functions as a Taylor, power, and Laurent series, and they classify singularities and poles, also able to find residues and evaluate complex integrals using the residue theorem.									
Unit – 1	Basic algebraic properties of complex numbers, Exponential form, Roots of complex numbers. Functions of a complex variable, mappings, Cauchy-Riemann equations, sufficient conditions for differentiability, Analytic functions, Harmonic functions. Elementary functions: The exponential, logarithm functions, branches and derivatives of logarithms. Complex exponents, trigonometric, hyperbolic functions and their inverses.								
Unit – 2	Integrals: Complex integrals, Upper bounds for moduli of contour integrals, Cauchy's theorem, Cauchy's integral formula, Liouvilles' theorem and fundamental theorem of algebra, maximum modulis principle. Series: Classification of singularities. Representations of holomorphic functions in terms of power series, Meromorphic functions, zeros and poles, Laurent expansions. Residues and Poles: poles and zeroes, Cauchy's residue theorem, Residue at								

	infinity, Residue at poles. Evaluation of improper integrals and definite integrals using contour integration. Argument principle and Rouche's theorem.
Unit – 3	Mapping by Elementary functions: Linear transformations, linear fractional transformations, other mappings by elementary functions. Conformal mapping: Preservation of angles, transformations of harmonic functions and boundary conditions. Applications of conformal mappings.
Text Books	
1. R. V. Churchill and J. W. Brown: Complex Variables and Applications, 8th edition, McGraw Hill, 2009. **2.** L. Ahlfors: Complex Analysis: an Introduction to the Theory of Analytic Functions of One Complex Variable, 3 rd edition, Tata McGraw Hill, 1979. **3.** E.T. Copson: Theory of Functions of a Complex Variable, Oxford University Press, 1970. **4.** J.B. Conway: Functions of One Complex Variable, 2nd edition, Narosa, 1973. **5.** D. Sarason: Complex Function Theory, 2nd edition, Hindustan Publishing Company, 2008. **6.** M.J. Ablowitz: Complex Variables Introduction and Applications, 2nd edition, Cambridge University Press, 2003. **7.** S. Ponnusamy and H. Silverman: Complex Variables with Applications, Birkh¨auser, 2006.	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 013020	**Statistics-II**	**Major**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: Statistics-I is the prerequisite for this course. The course is to design a statistical hypothesis about a real-world problem and conduct appropriate test for drawing valid inferences about the population characteristics. It is inevitable to have the knowledge of hypothesis testing for any research work. This course will provide an opportunity to learn R programming to a substantial extent. This course introduces the concepts and methods of probability and distribution theory and									

these tools are used to develop the theory of statistical estimation and hypothesis testing	
Course Outcomes (COs): After completion of the course students may calculate probabilities and quantiles for sampling distributions related to the normal distribution (t, chi-square, F); and apply the Central Limit Theorem to calculate probabilities and quantiles for the sample mean. Also They can construct point and interval estimators; evaluate their goodness (bias, variance, mean squared error). Furthermore, they can determine properties of point estimators (efficiency, consistency, sufficiency); find minimum variance unbiased estimators; and find methods of moments and maximum likelihood estimators. Finally, they perform hypothesis tests for the mean; compute p-values, and probabilities of Type I and Type II errors; determine the power of a test and apply the Neyman-Pearson Lemma; construct likelihood ratio tests	
Unit – 1	**Principle of Data Reduction:** Introduction, The Sufficiency Principle, Sufficient, Minimal Sufficient, Ancillary and Complete Statistics, Exponential Family, The Likelihood Principle, The Likelihood Function, The Equivariance Principle.
Unit – 2	**Point Estimation:** Introduction, Problem of Point Estimation, Unbiased Estimator, Uniformly Minimum Variance Unbiased Estimator, Lower Bound for the Variance of an Estimator, Method of Moments Estimators, Maximum Likelihood Estimators, Bayes Estimators.
Unit – 3	**Methods for Evaluating Estimators:** Introduction, Mean Squared Error, Standard Error of an Estimator, Best Unbiased Estimators, Sufficiency and Unbiasedness, Loss Function Optimality.
Unit – 4	**Confidence Interval (CI) Estimation:** Introduction, CI on Mean and Variance of a Normal Distribution, CI on a Proportion, CI on the difference between Means for Paired Observations, CI on the Ratio of Variances of two Normal Distributions, CI of the Difference Between two Proportions.
Unit – 5	**Tests of Hypotheses:** Introduction, Statistical Hypotheses, Type-I and Type-II Errors, One-Sided and Two-Sided Hypotheses, Tests of Hypotheses on the Mean of a Normal Distribution; Variance know as well as Unknown Cases, Tests of Hypotheses on the Variance of a Normal Distribution, Tests of Hypotheses on a Proportion, Tests of Hypotheses on the Means of Two Normal Distributions; Variances know as well as Unknown Cases, The Paired t-Test, Tests for Equality of two Variances, Tests of Hypotheses on two Proportions, Testing for Goodness of Fit, Contingency Table Tests, Neyman-Pearson Theory of Testing of Hypotheses, Uniformly Most Powerful Tests, Likelihood Ratio Tests, Unbiased Tests.
Unit – 6	**Asymptotic Evaluations:** Introduction, Consistency, Asymptotic Unbiasedness, Efficiency, Asymptotic Normality, Large Sample Interval Estimation, Large Sample Tests**.**
Text Books	

1. V.K. Rohatgi and A.K. Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley and Sons, Inc. 2003.
2. W.W. Hines, D.C. Montgomery, D.M. Goldsman, and C.M. Borror: Probability and Statistics in Engineering, John Wiley and Sons, 4th Edition, 2007.
3. G. Casella and R. L. Berger: Statistical Inference, Cengage Learning, 3rd Edition, 2008.
4. S.M. Ross: Introduction to Probability and Statistics for Engineers and Scientists, Academic Press. 3rd Edition, 2004.
5. S. C. Gupta and V. K. Kapoor: Fundamental of Mathematical Statistics, S. Chand, 2007.
6. A. M. Goon, M. K. Gupta, B. Dasgupta: Fundamental of Statistics, Vol. I, II, World Press, 2001
7. Whitney K. Newey and Daniel Mc Fadde, Large sample estimation and hypothesis testing, https://statweb.rutgers.edu/ztan/material/newey-mcfadden.pdf

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 013040	**Rings and Field**	**Optional**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: Group theory is the prerequisite for this course. This course covers well scientific knowledge of the theory of rings which is an important algebraic structure in mathematics(specifically in algebra). The course also covers the deep study of some interesting rings as Euclidean rings and a ring of polynomials over a field which is very useful in the study of finite fields and field extensions. These concepts have very important applications in Galois theory.

Course Outcomes (COs): After completion of this course the students acquire basic concepts of a Ring as an algebraic structure like the definitions of a Ring, Ideals, the factor ring, the automorphisms of a ring, principal ideal domain, prime and maximal ideals, the field of quotients of an integral domain, characteristic of a ring and direct sum of rings. Students construct finite fields from a field of polynomial over a finite field and an irreducible polynomial. A deep study of some important rings and field extensions that essentially arise from ideas of Galois Theory. The students cover the concept of finite fields which has a useful application in coding theory.

Unit – 1	**Review of Basic Ring theory:** Integral domain and field of Fraction, Prime Avoidance theorem, Unique factorization domain, Principal Ideal domain, Euclidean domain, Gauss lemma, Polynomial Rings, Power series ring, Group ring,
Unit – 2	**Fields:** Definition and examples, Irreducibility Criterions, Prime Subfield, Algebraic and transcendental elements and extensions.
Unit – 3	**Splitting field:** Splitting field of a polynomial. Existence and uniqueness of algebraic closure. Finite fields, Normal and separable extensions, Inseparable and purely inseparable extensions. Simple extensions and the theorem of primitive elements, Perfect fields.

Text Books

1. S. Lang: Algebra. Graduate Text in Mathematics, Revised 3rd Edition, Springer- Verlag, 2002.
2. M. Artin: Algebra. 2nd Edition Pearson Education, 2011.
3. S. Dummit and R.M. Foote: Abstract Algebra. 3rd Edition John Wiley and Sons Inc, 2004.
4. Musili: Introduction to Rings and Modules, 2nd edition, Narosa Publication, 1997.
5. N. Jacobson: Basic Algebra I, Basic Algebra II, 2nd Edition, Dover Publications, 2009.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 013060	**Mechanics – I**	**Major**	L	3	T	1	P	0	4

Pre-requisite :	
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)
Syllabus Version :	01

Course Objectives: Students will understand the vectorial representation of forces and moments. Student will gain knowledge in solving problems involving work and energy. Understand the basic physics associated with waves and oscillations and apply it to acoustics. To develop the understanding of modeling dynamic systems of engineering using vectoral approach and ability to model the engineering components as particles to study their Kinematics. Application of Newton's

laws to particles and systems of particles. Application of work energy principle, work momentum principle to particles and systems of particles. To study satellite motion using Kepler's Law and to understanding the principles of central force motion.

Course Outcomes (COs):

- Will learn about small oscillation, Inertia tensor, rigid body which will be helpful to know about the motion of our galaxy, stars etc.
- To solve the classical and wave mechanics problems
- To aware of limits of mechanics to apply the ideas in solving the problems in their parent streams.
- Understand the force systems and draw free body diagram to analyze rigid body equilibrium.
- Differentiate in strain energy stored in a body when the load is suddenly applied and gradually applied.
- Comprehend the general characteristics of central forces and the application of Kepler's laws to describe the motion of planets and satellite in circular orbit through the study of law of Gravitation.

Unit – 1	**Virtual Work:** Infinitesimal displacement of rigid body parallel to fixed plane; Principle of virtual work, work and potential energy.
Unit – 2	**Forces in three dimensions:** Acting at different points of a rigid body, their resultant, conditions of equilibrium, poinsot's central axis, Wrentch and Pitch, null lines and planes.
Unit – 3	**Equilibrium of strings and chains:** Common Catenary, suspension bridge, Catenary of uniform strength, strings on a smooth surfaces and curves. Strings under central forces, extensible strings.
Unit – 4	**Thin Beams and Flexible Cables:** Tension, Shearing force and Bending moment, general formulae for flexible cables hanging freely, common catenary, frames.
Unit – 5	**Kinematics of Particle and system:** Rectangular, Radial, transversed, tangential and normal velocities and accelerations, angular velocity and acceleration, principle of energy and angular momentum for a particle and a system.
Unit – 6	**Rectilinear Motion:** Motion with variable accelerations, harmonic oscillators, damped and forced oscillations. **Constrained Motion:** Motion of a particle in a vertical circle (inside and outside), in a cycloid, along a smooth plane curve.
Unit – 7	**Central Orbit:** Differential equation of a central orbit, law of force, velocity and periodicity for a given central orbit and the equation of orbit for a given law. Stability of a circular orbit. Planetary orbits, Keller's laws.

Text Books

1. S. L. Loney: An Elementary Treatise on STATICS, CUP, 1963.
2. S. L. Loney: The Elementary Treatise on the Dynamics of a Particle and the Rigid Bodies, CUP, 1919.
3. A. S. Ramsey: Dynamics, Vol. I, II, CUP, 1961.

4. I. H. Shames: *Engineering Mechanics: Statics and Dynamics*, Prentice Hall of India, 2006.
5. J. L. Synge and Griffith: *Principle of Mechanics*, McGraw Hill, 2007.
6. F. P. Beer and E. R. Johnston: *Vector Mechanics for Engineers*, Tata McGraw Hill, 2004.

Reference Books:

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 023020	**Number Theory**	**Minor**	L	3	T	1	P	0	4
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								

Course Objectives: The course aims to give elementary ideas of number theory which will have applications in cryptography. Reader Identify and apply various properties of and relating to the integers including the Well-Ordering Principle, primes, unique factorization, and the division algorithm, and understand the concept of quadratic congruence. Prime power module and primitive roots may help to improve the existing algorithm for primality testing and prime factorization problem which is highly applicable in coding theory and cryptography to develop new digital devices. This course also covers Euler's, Lagrange and Wilson theorem, Euler criterion, Legendre symbol, Law of quadratic reciprocity; neither Euler nor Legendre were able to prove this but Gauss, Pell's equation.

Course Outcomes (COs): After completing the course, students will be able to solve elementary number theory problems they can apply elementary number theory to cryptography. Develop a deeper conceptual understanding of the theoretical basis of number theory and identify how number theory is related to and used in cryptography.

Unit – 1	Divisibilty, division algorithm, Euclidean Algorithm, Algebraic congruences of higher degree. General Taylor Expansion Method for Prime Power Modulus Theorems of Euler, Lagrange and Wilson. Primality Testing and Factoring, Primitive Roots.
Unit – 2	Quadratic Congruence, Euler's Criteria and Legendre's Symbol, two squaretheorem, quadratic reciprocity law, Arithmetic function, Dirichlet product, Mobius inversion formula, divisor function .

Unit – 3	Simple continued fractions, Approximation to rational numbers, Hurwitz theorem, periodic continued fraction, Pell's Equation.
Text Books	
1. G.H. Hardy and E.M. Wright: An Introduction to The Theory of Numbers, 6th edition, Oxford University Press, 2008. **2.** D.M. Burton: Elementary Number Theory, 6 th edition, McGraw-Hill, 2005. **3.** I. Niven, H.S. Zuckerman and H.L. Montgomery: An Introduction to The Theory of Numbers, 5th edition, Wiley, 1991. **4.** T. M. Apostol: Introduction to Analytic Number theory, Springer-Verlag 1976	
Reference Books:	

Course Code	Course Title	Course Type	Contact Hours						Credit
MAT 023040	**Group Theory**	**Minor**	L	2	T	0	P	0	2
Pre-requisite	:								
Course Assessment Methods :	As per CUJ norms (60 marks from end semester and 40 marks from sessional examinations)								
Syllabus Version :	01								
Course Objectives: The main aim of the course is to introduce basic concepts of abstract algebra, especially the notion of a group. The course will help us to prepare for further study in abstract algebra and many other areas of mathematics. Group theory is one of the great simplifying and unifying ideas in modern mathematics. It plays a major role in our understanding of fundamental particles, the structure of crystal lattices, and the geometry of molecules.									
Course Outcomes (COs): At the end of the course students are able to understand the concept of algebraic structures, groups, rings, fields, modules, etc. Students are also able to understand concepts of abelian, symmetric, cyclic, quotient, normal, Sylow groups, homomorphism, isomorphism, and their properties. Further, students can understand the integral domain, zero divisors, division ring, ring homomorphism, and field.									
Unit – 1	Semigroups, Groups, Homomorphisms, Subgroups, Permutation Groups, Normal Subgroups, Isomorphism Theorem, Automorphisms, Conjugacy and G-sets.								

Unit – 2	Normal Series, Solvable groups, Nilpotent groups, Cyclic decomposition of permutations, Alternating group. Structure Theorem of Finite abelian groups. Sylows theorems, groups of orders p^2, pq.
Text Books	
1. P.B. Bhattacharya, S. K. Jain and S. R. Nagpaul: *Basic Abstract Algebra*, 2nd edition, Cambridge University Press, 1995. 2. J. A. Gallian*: Contemporary Abstract Algebra*, 4th edition, Narosa, 1998. 3. D. S. Dummit and R. M. Foote: *Abstract Algebra*, 2nd edition, Wiley, 1999. 4. I. N. Herstein: *Topics in Algebra*, 2nd edition, Wiley, 1975.	
Reference Books:	

Signature of the Head of Department with seal