Department of Mathematics

Core Courses:

1. Differential Calculus
2. Differential Equations
3. Real Analysis
4. Algebra

Discipline Specific Elective Courses

1. Matrices
2. Calculus Without Limits
3. Probability & Statistics
4. Numerical Methods
5. Integral Calculus
6. Elementary Inference

Skill Enhancement Courses:

1. Special Function & Integral Transform
2. Linear Algebra
3. Vector Calculus
4. Operations Research
5. Complex Analysis
6. Computer Fundamentals

1. Name of the Department: Mathematics						
2. Course Name	Differential Calculus	**L**	**T**		**P**	
3. Course Code	09010117	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course is designed to develop the topics of differential calculus. Emphasis is placed on limits, continuity, derivatives. Upon completion, students should be able to select and use appropriate models and techniques for finding solutions to derivative-related problems with and without technology.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. Learn to find and use limits of functions,
2. Apply the Mean Value Theorem.
3. Find intervals of concavity and points of inflection of elementary algebraic functions and trigonometric functions.
4. Find Curvature and Asymptotes.

10. Course Outcomes (COs):

After completing the course, students are expected to be able to evaluate various limi& continuity problem, Curvature, Mean value theorems and applications of Partial Differential equations.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Continuity and Differentiation**

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, nth differentiation of functions, Leibnitz's theorem.

Unit – 2	**Number of lectures = 9**	**Title of the unit: Asymptote and Curve Tracing**

Asymptotes in Cartesian coordinates, Asymptotes in polar coordinates, Oblique Asymptotes, Concavity, Convexity & Points of Inflexion, Tangents and normal Curvature, Singular points, Tracing of curves in Cartesian, Parametric and polar co-ordinates

Unit – 3	**Number of lectures = 9**	**Title of the unit: Mean Value Theorems**

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cos x, e^x , log(l+x), $(l+x)^m$, Maxima and Minima, Indeterminate forms.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Curvature**

Curvature, radius of curvature for Cartesian Curves, Parametric curves, polar curves, Newton's method. Radius of Curvature for pedal curves. Tangential polar equation, Center of curvature. Circle of curvature. Chord of curvature, Evolutes.

Unit – 5	**Number of lectures = 8**	**Title of the unit: Partial Differentiation**

Partial differentiation, Euler's theorem on homogeneous functions, Differentiability of functions of two variables, Change of variables, Taylors theorem for two variables, Composite functions and Implicit & explicit functions, Total differentials.

12. Books Recommended

1. Shanti Narayan: Differential and Integral Calculus.
2. Murray R.Speigel: Theory and Problems of Advanced Calculus, Schaum's Outline series, Schaum Publishing Co., New York.
3. N. Piskunov: Differential and Integral Calculus, Peace Publishers, Moscow.
4. Gorakh Prasad: Differential Calculus, Pothishasla Pvt. Ltd. Allahabad.
5. Gorakh Prasad: Integral Calculus, Pothishasla Pvt. Ltd. Allahabad

1. Name of the Department: Mathematics						
2. Course Name	Differential Equations	**L**	**T**		**P**	
3. Course Code	09010216	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

Differential equations and their solutions. Linear Differential equation. Homogeneous Differential Equations. Second order linear differential equations. Total differential equations.

9. Course Objectives:

To introduce the basic concept of Differential equations and their solutions. Strength of these concepts in engineering and real world problems will be highlighted.

10. Course Outcomes (COs):

1. Differential Equations are used in many models to determine how the state of model is changing regarding time or any other variable.
2. Its application is inevitably based on mathematical theories of reality

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the Unit: Introduction to Differential Equations**

Order and degree of a differential equation, Linear & Non-Linear Differential equation, Homogeneous equations, Geometrical meaning of DE, Exact DE, Integrating factors, First order higher degree equations solvable for x,y,p, Lagrange's equation, Clairaut's equations, Equations reducible to Clairaut's form, Singular solutions

Unit - 2	**Number of lectures = 8**	**Title of the unit: Orthogonal Trajectories and Homogeneous DE**

Orthogonal trajectories in Cartesian coordinates and polar coordinates, Self orthogonal family of curves, Linear DE with constant coefficients, Homogeneous linear ODE, Equations reducible to homogeneous

Unit - 3	**Number of lectures = 8**	**Title of the unit: Linear DE and Non-homogeneous DE**

Linear DE of second order: Reduction to normal form, Transformation of the equation by changing the dependent variable/independent variable, Solution by operators of non-homogeneous linear DE, Reduction of order of a DE

Unit - 4	**Number of lectures = 9**	**Title of the unit: Named Methods to solve DE and Solutions of Simultaneous DE**

Method of variations of parameters, Method of undetermined coefficients, Ordinary simultaneous DE, Solution of simultaneous DE involving operators x (d/dx) or t (d/dt) etc, Simultaneous equation of the form dx/P=dy/Q=dz/R .

Unit - 5	**Number of lectures = 8**	**Title of the unit: Total DE and their methods to solve**

Total DE, Condition for Pdx+Qdy=Rdz=0 to be exact, General method of solving Pdx+Qdy+Rdz=0 by taking one variable constant, Method of auxiliary equations

12. Books Recommended

1. D.A. Murray: Introductory Course in Differential Equations. Orient Longaman (India), 1967
2. A.R.Forsyth: A Treatise on Differential Equations, Machmillan and Co. Ltd. London
3. E.A. Codington: Introduction to Differential Equations.
4. S.L.Ross: Differential Equations, John Wiley & Sons
5. B.Rai and D.P. Chaudhary: Ordinary Differential Equations; Narosa, Publishing House Pvt. Ltd

1. Name of the Department: Mathematics						
2. Course Name	Real Analysis	**L**	**T**		**P**	
3. Course Code	09010316	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**			**Practicals: 0**	

8. Course Description:

Real analysis is a large field of mathematics based on the properties of the real numbers and the ideas of sets, functions, and limits. Topics covered are: Countable and uncountable sets, the real numbers and their properties, least upper bounds, the Archimedean property and completeness, sequences of real numbers, convergence, subsequences, and Cauchy sequences. Bolzanno-Weierstrass property and compactness, Limit, Continuous functions and their properties, the Riemann integral and its properties, the fundamental theorem of calculus, convergence of sequences and series of functions etc.

9. Course Objectives:

The objective of this course are:

1. Define the real numbers, least upper bounds,
2. Define Bolzano –Weirstrass theorem and Cauchy criteria.
3. Define functions between sets; equivalent sets; finite, countable and uncountable sets. Recognize convergent, divergent, bounded, Cauchy and monotone sequences.
4. Calculate the limit superior, limit inferior, and the limit of a sequence.
5. Recognize alternating, convergent, conditionally and absolutely convergent series.
6. Apply the ratio, root and limit comparison tests.
7. Define metric and metric space, subsets of a metric space are open, closed, connected, bounded.
8. Determine if a function on a metric space is discontinuous, continuous, or uniformly continuous.

10. Course Outcomes (COs):

On successful completion of this course, students will be able to:

1. describe fundamental properties of the real numbers that lead to the formal development of real analysis.
2. define convergence of series using the Cauchy criterion and use the comparison, ratio, and root tests to show convergence of series.
3. define continuity; state, prove, and use properties of limits of continuous functions, including the fact that continuous functions attain extreme values on compact sets.
4. demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.
5. construct rigorous mathematical proofs of basic results in real analysis.
6. state the Fundamental Theorem of Calculus and use it in proofs.
7. construct the Riemann Integral and state its properties.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Real Number System**

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, completeness property of R, Archimedean property of R, intervals, Boundedness of the set of Real

numbers, Least upper bound and Greatest lower bound of a set, Neighborhoods, interior points and isolated points, Limit points, open sets, closed sets, Interior of a set, Closure of a set in Real numbers and their properties, Bolzano-Weierstrass theorem.

Unit - 2	**Number of lectures = 8**	**Title of the unit: Sequences**

Sequences: Real sequences and their convergence, Subsequences, Theorem on limits of sequences, Divergent sequence, Bounded sequence, Monotonic sequence, Monotone convergence theorem, Cauchy's sequence, Cauchy general principle of convergence.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Infinite Series**

Infinite series: Convergence and divergence of infinite series, Comparison tests of positive term infinite series, Cauchy's general principle of convergence of series, Convergence and divergence of geometric series, Auxiliary series or p-series, D-Alembert's ratio test, Rabbe's Test, Logarithmic Test, De Morgan and Bertrand's Test, Cauchy n^{th} Root Test, Gauss Test, Cauchy Integral test, Cauchy's condensation test, Alternating series: Leibnitz's Test, absolute and conditional convergence, Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M-test.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Metric Spaces**

Definition and examples of metric spaces, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle.

Unit-5	**Number of lectures = 8**	**Title of the unit: Riemann integral**

Riemann integral, Integrabililty of continuous and monotonic functions, The Fundamental theorem of integral calculus, Mean value theorems of integral calculus.

12. Books Recommended

1. P.K. Jain and Khalil Ahmed: Metric spaces, 2nd Ed., Narosa, 2004
2. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
3. R.R. Goldberg: Real Analysis Oxford & IBH publishing Co., New Delhi, 1970
4. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
5. R.R. Goldberg: Real Analysis Oxford & IBH publishing Co., New Delhi, 1970
6. D. Somasundaram and B. Choudhary: A First Course in Mathematical Analysis, Narosa Publishing House,New Delhi, 1997

1. Name of the Department: Mathematics						
2. Course Name	Algebra	**L**	**T**		**P**	
3. Course Code	09010414	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course covers properties of groups, permutation groups, cyclic groups, Lagrange's Theorem, subgroups, normal subgroups, quotient groups, external direct product of groups, homomorphism and isomorphism of groups, and introduction to rings and fields.

9. Course Objectives:

This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called groups, rings, fields and some related structures. Abstract algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill.

10. Course Outcomes (COs):

Upon completion of the course, students will be able to:

1. Demonstrate knowledge and understanding of groups, subgroups, and order of an element in finite groups.
2. Demonstrate knowledge and understanding of the concept of cosets of a subgroup of a group, normal subgroups, symmetric groups, cyclic groups and their properties.
3. Demonstrate knowledge and understanding of direct product of groups, quotient groups, group homomorphism and isomorphism.
4. Demonstrate knowledge and understanding of rings, subrings, integral domains, fields, Euclidean ring and unique factorization domain.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Groups, Subgroups and Cyclic groups**

Definition of a group with example and simple properties of groups, Subgroups and Subgroup criteria, Generation of groups, cyclic groups

Unit – 2	**Number of lectures = 8**	**Title of the unit: Cosets and Normal Subgroups**

Cosets, Left and right cosets, Index of a sub-group Coset decomposition, Largrage's theorem and its consequences, Normal subgroups, Quotient groups

Unit – 3	**Number of lectures = 8**	**Title of the unit: Homomorphism and Automorphism**

Homomorphisms, isomophisms, automorphisms and inner automorphisms of a group. Automorphisms of cyclic groups

Unit – 4	**Number of lectures = 8**	**Title of the unit: Permutations and Alternating groups**

Permutations groups. Even and odd permutations. Alternating groups, Cayley's theorem, Center of a group and derived group of a group.

Unit – 5	**Number of lectures = 10**	**Title of the unit: Rings, Integral Domain & Fields**

Introduction to rings, subrings, integral domains and fields, Characteristics of a ring. Ring homomorphisms, ideals (principle, prime and Maximal) and Quotient rings, Field of quotients of an

integral domain. Euclidean rings, Polynomial rings, Polynomials over the rational field, The Eisenstein's criterion, Polynomial rings over commutative rings, Unique factorization domain, R unique factorization domain implies so is R[X1 , X2……Xn]

12. Books Recommended

1. N Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. Joseph A. Gallian, Contemporary Abstract Algebra, 4th, Narosa Publishing House, 1999.
3. B. Bhattacharya, S.K. Jain and S.R. Nagpal : Basic Abstract Algebra (2nd edition)
4. A Text Book of Modern Abstract Algebra, Shanti Narayan
5. S.Luther and I.B.S. Passi : Algebra, Vol. II, Narosa Publishing House.
6. John B. Fraleigh, A First course in Abstract Algebra, 7th, Pearson, 2002.

1. Name of the Department : Mathematics						
2. Course Name	Matrices	**L**	**T**		**P**	
3. Course Code	09010523	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

The course covers the concepts of matrices. This course covers the types of matrices and Rank of matrices. This course also covers the some basic concepts and examples(R, R^2, R^3 as vector spaces over R)of vector spaces.

9. Course Objectives:

The objective of this course is to make the students able to understand matrices and properties of matrices. It also makes the students able to solve system of linear equations (Both Homogeneous and Non Homogeneous).

10. Course Outcomes (COs):

1. Students in this course will demonstrate ability to work with matrices.
2. Students in this course will demonstrate ability to solve system of linear equations.
3. Students in this course will come to know about some basic examples of vector spaces.
4. Students in this course will demonstrate ability to work with Bilinear and quadratics forms of matrices.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Vector Spaces**

R, R^2, R^3 as vector spaces over R, Standard basis for each of them, Concepts of Linear Independence and examples of different bases, Subspaces of R^2 and R^3

Unit – 2	**Number of lectures = 8**	**Title of the unit: Basic Geometric Transformations**

Translation, Dilation, Rotation, Reflection in a point, line and plane, Matrix form of basic geometric transformations, Interpretation of Eigen values and Eigen vectors for such transformations and Eigen spaces as invariant subspaces.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Matrices**

Algebra of matrices, Types of matrices e.g. Symmetric & Skew- Symmetric matrices, Hermitian ,Skew-Hermitian matrices, Unitary and orthogonal matrices, Nilpotent and Involutary matrices, Eigen values, eigenvectors of matrices, Characteristic Equation of a matrix, Minimal polynomial of a matrix, Cayley Hamilton Theorem and its use in finding inverse of a matrix.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Rank of Matrices**

Elementary operations on matrices, Rank of matrices ,inverse of matrices, Linear dependence and Linear independence of rows and columns, Homogeneous and non Homogeneous system of linear equations, Application of matrices to a system of linear equations with number of variables & equation upto 4, Theorems on consistency of a system of linear equation

Unit – 5	Number of lectures = 8	Title of the unit: Normal form, Quadratic and Bilinear form of matrices
Reduction to normal form of a matrix, Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3, Bilinear and Quadratic forms of matrices		

12. Books Recommended

1. A.I. Kostrikin, Introduction to Algebra, Springer Verlag, 1984
2. S. H. Friedberg, A. L. Insel and L. E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989

1. Name of the Department Mathematics						
2. Course Name	Calculus Without Limit	**L**	**T**		**P**	
3. Course Code	09010524	**5**	**1**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course is designed to develop the topics of Differential and Integral Calculus. Emphasis is placed on limit, Continuity, Derivative and integral of algebraic and Transcendental function.

9. Course Objectives:

The current Standard for the Calculus Curriculum is failure in many aspect .We try to present it with modern standard of Mathematical rigor.

10. Course Outcomes (COs):

After Completion of the Course the Student will be able to interpret a function from an Algebraic, Numeric. Graphical. Also we expects Students to have a reasonable mastery.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Brief History of Background and Geometric Numeric**

How and Why Europeans misunderstood Indian Airthemetic, Fibonacci and Florentine law, Zero, Surd, Fractions Misunderstanding of Trigonometry and Conceptual confusion, Measurement of an angles through arcsin radians ,Trigonometric values: past and present: progress or regress ?,Finite differences vs derivatives : chord vs tangent .,Error and myth of perfection. ,Zeroism.

Unit - 2	**Number of lectures = 8**	**Title of the unit: Differential Equations Basics**

Relation between values and differences, The fundamental theorem of calculus, Proportionality relation between sine and cosine ,.Differential equations vs difference equations. Using calcode , Aryabhatta - Euler method

Unit - 3	**Number of lectures = 8**	**Title of the unit: Application of Ordinary Differential Equation**

Problems of Newtonian Physics , Example problems: The amplitude dependence of the time period of the Simple pendulum , Jacobian Elliptic Functions , Solving 2-body problem of Newtonian Gravitation, Trajectory problems , Examples of chaotic motion and few more

Unit - 4	**Number of lectures = 10**	**Title of the unit: Symbolic Manipulation and Number System with Limit**

Introducing Maxima and using it for symbolic manipulation, Evaluating symbolic derivatives, integrals and elliptic integrals. Origin of formal real numbers, Dedekind cuts ,Problem of Cantorian and naïve set theory Russell paradox ,Limits and Cauchy sequences ,Archimedean ordered field ,Obtaining limits by discarding infintesimals Computers and floating point numbers ,Extended precision

Unit - 5	**Number of lectures = 6**	**Title of the unit: Higher Order Polynomial interpolation**

Brahma Gupta, Vateshwar - Stirling Formula and quadratic interpolation Runga kutta and higher order polynomial interpolation, Accelerating convergence.

12. Books Recommended

1. C.K. Raju, 'Cultural foundations of mathematics: the nature of mathematical proof and the transmission of calculus from India to Europe in the 16thCentury, CE, Pearson Longman, 2007.
2. C.K. Raju 'Eternity and infinity: The western understanding of Indian mathematics and its consequences for science today', American Philosophical Association Newsletter on Asian and Asian American Philosophers and Philosophies, 14(2), 27-33, 2015.
3. H. Flanders, R. Korfhage, J. Price, 'Calculus', Academic Press, New York, 1970.
4. D.V. Widder, 'Advanced Calculus', 2nd Ed., Prentice Hall, New Delhi, 1999.
5. W. Rudin, 'Principles of mathematical analysis', Mc Graw Hill, 1964.
6. L. Mendelson, 'Introduction to mathematical logic', van Nostrand Reinhold, New York, 1964.
7. P.R. Halmos, 'Naïve Set Theory', East – West Press, New Delhi, 1972.
8. C.K. Raju, 'Éuclid and Jesus: how and why the church changed mathematics and christanity across two religious wars', Multiversity, Penang, 2012.
9. C.K. Raju, 'Computers, mathematics education, and the alternative epistemology of the calculus in Yuktibhasa', Philosophy east and west, 51(3), pp. 325-361, 2001.
10. C.K. Raju, 'Logic', Encyclopaedia of Non-Western Science, Technology and Medicine, Springer, 2016, pp 2564-2569, 2008.
11. C.K. Raju, 'The religious roots of Mathematics', Theory, Culture and Society, 23(1-2), pp. 95-97, 2006.
12. C.K. Raju, 'Cultural Foundation of Mathematics', Pearson, Longman, 2007.
13. C.K. Raju, 'Zeroism', article in Encyclopedia of Non-western Science, Technology and Medicine, ed. Helaine Celin, Springer, Dordrecht, pp. 4604-4610, 2016.
14. GhadarJari Hai, 2(1), pp. 26-29, 2007.
15. C.K. Raju, 'Teaching Mathematics with a different philosophy, Part 1: Formal mathematics as blased metaphysics', Science and Culture, 77(7-8), pp. 274-279, 2011.
16. C.K. Raju, Calculus without Limits, paper for 2nd people's congress of education, Homi Bhabha Center, Mumbai.

1. Name of the Department: Mathematics						
2. Course Name	Probability & Statistics	**L**	**T**		**P**	
3. Course Code	09010525	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**		**Practical = 0**		

8. Course Description:

This course provides a solid undergraduate foundation in both probability theory and mathematical statistics. Topics include: Basics in probability theory, random variables, expectation and variance, special probability distributions.

9. Course Objectives:

1. To develop the skills of the students in the area of Probability and Statistics
2. To expose the students to the basics of probability distributions and application of family of random variables in real life situations
3. Students should understand basic concepts in probability theory and mathematical statistics learn commonly used probability distributions.

10. Course Outcomes (COs):

After successfully completing of this course, students will be able to:

1. Apply the knowledge gained in Probability theory in Medical Sciences, Life Sciences and Engineering fields.
2. Translate real world problems into Probability models

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Probability and Random Variables**

Introduction, random experiment, trial, sample space, events, Definitions of probability, random variables (discrete and continuous type), probability mass function (p.m.f.), probability density function (p.d.f.) and cumulative distribution function (c.d.f.)

Unit - 2	**Number of lectures = 9**	**Title of the unit: Two dimensional Random Variable**

Two dimensional random variables (discrete and continuous type), joint and marginal p.m.f, p.d.f., c.d.f., conditional distributions and independent random variables.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Expectation and generating Function**

Expectation of single and bivariate random variables, moments and moment generating function along with their properties, Conditional expectations.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Discrete Probability Distributions**

Bernoulli, Binomial, Poisson along with their properties.

Unit - 5	**Number of lectures = 8**	**Title of the unit: Continuous Probability Distributions**

Uniform, normal, exponential along with their properties.

12. Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
3. Gupta, S.C. and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2008.

1. Name of the Department: Mathematics						
2. Course Name	Numerical Method	**L**	**T**		**P**	
3. Course Code	09010623	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course analyzed the basic techniques (direct and iterative methods) for the efficient numerical solution of problems in science and engineering. Topics s covered are: Number representation and errors, Polynomials, Locating roots of equations, Solution of nonlinear equations, Interpolation and approximation, Numerical differentiation, Numerical integration, Systems of linear equations, Solution of differential equations

9. Course Objectives:

Many applications in engineering, physics, geology and other specifications containing complicated problems that will require one of the numerical methods to be solved. In this course students will learn the classification of many complicated problems and the suitable numerical methods for obtaining an approximated solution to these problems with desired accuracy.

10. Course Outcomes (COs):

On completion of this course, the students will learn

1. Practical and theoretical knowledge of a range of iterative techniques for solving linear and nonlinear systems of equations
2. Practical and theoretical knowledge of polynomial interpolation,
3. Practical and theoretical knowledge of schemes for numerical integration
4. Practical and theoretical knowledge of schemes for solving differential equations

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Errors & Solution of transcendental and algebraic equations**

Representations of numbers: Roundoff error, truncation error, significant error, error in numerical computations. Bisection, secant, Regula Falsi, fixed-point, Newton-Raphson, Graffe's methods.

Unit-2	**Number of lectures = 8**	**Title of the unit: Interpolation & Approximation**

Difference schemes, interpolation formulas using differences. Lagrange and Newton interpolation. Hermite interpolation. Divided differences, Different types of approximation, least square polynomial approximation.

Unit-3	**Number of lectures = 9**	**Title of the unit: Numerical differentiation & Numerical integration**

Numerical differentiation, Methods based on interpolations, Methods based on finite differences, Numerical integration: Trapezoidal, Simpson's, and Weddle's rules. Gauss Quadrature Formulas

Unit- 4	**Number of lectures = 8**	**Title of the unit: Solution of linear equations**

Direct methods - Gauss elimination, Gauss-Jordan elimination, LU decomposition. Iterative methods - Jacobi, Gauss-Siedel; The algebraic eigenvalue problem: Jacobi's method, Power method.

Unit – 5	Number of lectures = 8	Title of the unit: Numerical Solution of IVP (ODEs)
Ordinary differential equations (ODEs): Euler's method, Single-step methods, Runge Kutta's method, multi-step methods		

12. Books Recommended

1. Richard L. Burden and J. Douglas Faires, Numerical Analysis, Brookes Cole 2004.
2. M.K. Jain, S.R.K. Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, New Age international Publishers, New Delhi, India, 2003.
3. Chapra, S. and R. Canale, Numerical Methods for Engineers. New York: McGraw Hill 1998.

1. Name of the Department						
2. Course Name	Integral Calculus	**L**	**T**		**P**	
3. Course Code	09010624	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**		**Practical = 0**		

8. Course Description:

Concept of integration and its application to physical problems such as evaluation of areas, volumes of revolution, force, and work; fundamental formulas and various techniques of integration applied to both single variable and multi-variable functions; tracing of functions of two variable. It is an introduction to the theory and applications of integral calculus of functions of one variable. It includes most of the basic topics of integration on functions of a single real variable: the fundamental theorem of calculus, applications of integrations, and techniques of integration, sequences, and infinite series. The emphasis in this course is on problem solving, not on the presentation of theoretical considerations

9. Course Objectives:

1. Understand the meaning of differentiation and integration.
2. Apply the various methods of calculating derivative of a function.
3. Apply techniques of indefinite and definite integration.

10. Course Outcomes (COs):

1. Calculus is a primary gateway to an engineering and engineering technology
2. Properly carry out integration through the use of the fundamental formulae and/or the various techniques of integration for both single and multiple integral.
3. Correctly apply the concept of integration in solving problems involving evaluation of arc lengths, areas, volumes, work, and force

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Integration Concept/ Formula**
Anti-Differentiation. The Definite Integral, Simple Power Formula, Simple trigonometric Functions, Logarithmic and exponential Functions, Inverse trigonometric Functions, Hyperbolic Functions, General Power Formula, Constant of Integration, Definite Integral		
Unit - 2	**Number of lectures = 9**	**Title of the unit: Integration Techniques**
Integration by Parts, Trigonometric Integrals, Trigonometric Substitution, Rational Functions, Rationalizing Substitution, Definite Integrals, Wallis' Formula, Partial fractions		
Unit - 3	**Number of lectures = 8**	**Title of the unit: Applications**
Improper Integrals, Plane Area, Arc Length, Areas Between Curves, Centroids, Moments of Inertia, Volumes, Work, Hydrostatics Pressure and Force.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Surface Multiple Integral as Volume**
Surface Tracing: Planes, Spheres, Cylinders, Quadratic Surfaces, Double Integrals, Triple Integral		
Unit - 5	**Number of lectures = 8**	**Title of the unit: Application**

Integral as limit of a sum. Fundamental Theorem of Calculus. Properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.

12. Books Recommended

1. Yuri A. Brychkov (Ю. А. Брычков), Handbook of Special Functions: Derivatives, Integrals, Series and Other Formulas. Russian edition, Fiziko-Matematicheskaya Literatura, 2006. English edition, Chapman & Hall/CRC Press, 2008
2. Richard Courant: Differential And Integral Calculus, Vol. 2
3. Martin Braun : Differential Equations and Their Applications 4th Ed.

1. Name of the Department: Mathematics						
2. Course Name	Elementary Inference	**L**	**T**		**P**	
3. Course Code	09010625	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course introduces students to the basic theory behind the development and assessment of statistical analysis techniques in the areas of point and interval estimation, as well as hypothesis testing.

Topic includes: Point estimation and interval methods, including method of moments and maximum likelihood, unbiasedness, consistency, efficiency and sufficiency, hypothesis testing methods and related confidence interval.

9. Course Objectives:

The objective of the course are to:

1. Familiar the students about method of maximum likelihood and the properties of good estimators.
2. Familiar the students with the concept of statistical inference, point and interval estimation, hypothesis testing under a large variety of discrete and continuous probability models.
3. Familiar the students about ANOVA

10. Course Outcomes (COs):

Upon successful completion of this course the students are able to perform the following:

1. How to apply discrete and continuous probability distributions to various business problems.
2. Perform Test of Hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases.
3. Learn non-parametric test such as the Chi-Square test for Independence as well as Goodness of Fit.
4. Perform ANOVA and F-test

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Estimator and their properties**

Parameter and statistic, sampling distribution and standard error of estimate. Point and interval estimation, Unbiasedness, Efficiency, Consistency and Sufficiency.

Unit - 2	**Number of lectures = 9**	**Title of the unit: Basic of Hypothesis and Method of Estmation**

Method of maximum likelihood estimation. Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Types of errors, Neyman- Pearson Lemma.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Large Sample Test**

Testing and interval estimation of a single mean, single proportion, difference between two means and two proportions.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Small Sample Test**

Definition of Chi-square statistic, Chi-square tests for goodness of fit and independence of attributes.

Definition of Student's't' and Snedcor's F-statistics. Testing for the mean and variance of univariate normal distributions, Testing of equality of two means and two variances of two univariate normal distributions. Related confidence intervals.		
Unit - 5	**Number of lectures = 8**	**Title of the unit: ANOVA**
Analysis of variance (ANOVA) for one-way and two-way classified data.		

12. Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Gupta, S.C. and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2008.
3. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the theory of Statistics, McGraw Hill, 1974.
4. A.M. Goon, M.K. Gupta, and B. Das Gupta, Fundamentals of Statistics, Vol-II.
5. R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics.

1. Name of the Department: Mathematics						
2. Course Name	Special Function and Integral Transform	**L**	**T**		**P**	
3. Course Code	09010626	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practicals: 0**

8. Course Description:

Integral transforms and special functions belong to the basic subjects of mathematical analysis, the theory of differential and integral equations and to many other areas of mathematics.

9. Course Objectives:

These subjects are under intense development, for use in pure and applied mathematics, engineering and computer science.

The main use of Integral Transforms and Special Functions is to further growth by providing a means for the publication of important research.

10. Course Outcomes (COs):

At the end of the course, the student will be able:

1. To solve Linear Differential Equations using Power-Series Methods
2. To learn Special functions like Legendre, Bessel, Chebyshev functions.
3. To know how root finding techniques can be used to solve practical engineering problems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Beta and Gamma function**

Series solution of Des-Power series method, Definitions of Beta and Gamma functions, Bessel equation and its solution.

Unit – 2	**Number of lectures = 7**	**Title of the unit: Bessel function**

Bessel functions and their properties, Relations and generating functions, Orthogonality of Bessel functions.

Unit – 3	**Number of lectures =10**	**Title of the unit: Recurrence relations and generating functions**

Legendre and Hermite DEs and their solutions ,Legendre and Hermite functions and their properties, Recurrence relations and generating functions, Orthogonality of Legendre and Hermite polynomials, Rodrigues' formula for Legendre and Hermite polynomials, Lapalace integral representation of Legendre polynomial.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Laplace transforms and Application**

Laplace transforms, Existence theorem for Laplace transforms, Linearity of the Laplace transforms, Shifting theorems, Convolution theorem, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Inverse Laplace transforms, Solution of ODEs using Laplace transform.

Unit – 5	**Number of lectures = 7**	**Title of the unit: Fourier transforms**

Fourier transforms-Linearity property, Shifting, Modulation, Convolution Theorem, Fourier transform of derivatives, Relations between Fourier transform and Laplace transform, Parseval's Identity for Fourier transforms, Solution of DEs using Fourier Transforms.

12. Books Recommended

1. Advanced Engineering Mathematics: R.K. Jain and S.R.K. Iyengar Narosa Publishing House
2. Advanced Engineering Mathematics: Erwin Kreyszig- Wiley Publications
3. Higher Engineering Mathematics: B.S. Grewal-Khanna Publications

1. Name of the Department: Mathematics						
2. Course Name	Linear Algebra	**L**	**T**		**P**	
3. Course Code	09010602	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course covers the basic concepts of Linear Algebra. This course covers the concept of Vector spaces, Basis and Dimension of vector spaces, Quotient spaces etc. It also covers Linear Transformations and algebra of linear transformations. This course also covers the concepts of Inner product spaces.

9. Course Objectives:

The Objective of this course is to present the basic concepts of Vector Spaces and Linear Transformations. The course also presents basic concepts of Inner product Spaces.

10. Course Outcomes (COs):

1. Students in this course will demonstrate ability to work within vector spaces.
2. Students in this course will demonstrate ability to distill vector space properties.
3. Students in this course will demonstrate ability to manipulate linear transformations.
4. Students in this course will demonstrate ability to work within Inner product spaces.

11. Unit wise detailed content

Unit-1	**Number of lectures = 5**	**Title of the unit: Vector Spaces**

Definition and examples of vector spaces, Subspaces. Sum and direct sum of subspaces, Linear span, Linear dependence and independence and their basic properties.

Unit – 2	**Number of lectures = 7**	**Title of the unit: Finite Dimensional vector spaces**

Basis of a vector space, Finite dimensional Vector spaces, Existence theorem for bases, Invariance of the number of elements of a basis set, Quotient spaces. Dimensions of quotient spaces.

Unit – 3	**Number of lectures = 6**	**Title of the unit: Linear Transformations**

Linear transformations, Null space, Range space of a linear transformation, Rank & Nullity of linear transformation, Matrix of a linear transformation and Change of basis

Unit – 4	**Number of lectures = 6**	**Title of the unit: Algebra of Linear Transformations**

Algebra of linear transformations, Singular and Non –Singular linear transformation, Eigen values and Eigen vector of linear transformations, Minimal polynomial of linear transformation, Dual spaces, Bidual spaces

Unit – 5	**Number of lectures = 6**	**Title of the unit: Inner Product Space**

Inner product spaces, Cauchy Schwarz inequality, Orthogonal vectors, orthogonal complements, Orthogonal sets and basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt Orthogonalization process

12. Books Recommended

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007
3. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
4. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007

1. Name of the Department: Mathematics						
2. Course Name	Vector Calculus	**L**	**T**		**P**	
3. Course Code	09010627	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

Course in multivariable Calculus. Topics include scalar and vector product, gradient divergence and curl; line and surface integrals; and the theorems of Green, Stokes, and Gauss.

9. Course Objectives:

Students will be able to understand:

1. Scalar and vector quantities. Types of vector, Directional vector, Evaluate vector integration of Surface & Volume, Theorems of Gauss, Green and Stokes and problem based on these theorems.
2. To make students familiar with Curl, Divergence, Gradient and its properties. Laplacian operator, spherical and curvilinear coordinates etc.

10. Course Outcomes (COs):

After completing the course, students are expected to be able to Compute dot product, cross product, length of vectors. Compute partial derivatives, derivatives of vector-valued functions, gradient functions. Evaluate integrals of functions or vector-related quantities over curves, surfaces, and domains in two- and three-dimensional space.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Scalar and Vector Product**
Scalar and vector product of three vectors and four vectors, Reciprocal vectors, Vector differentiation, Scalar valued point function and vector valued point function, Derivative along curve, Directional derivatives.		
Unit – 2	**Number of lectures = 6**	**Title of the unit: Gradient, Divergence and Curl**
Gradient of scalar point function, Divergence and curl of a vector point function, Characters of Div f and curl f of a vector point function, Vector identities , Gradient, Divergence and curl of sums and product and their related vector identities.		
Unit – 3	**Number of lectures = 6**	**Title of the unit: Gradient, Divergence and Curl in orthogonal curvilinear coordinates**
Gradient, Divergence, Curl and Laplacian operator in terms of orthogonal curvilinear coordinates, Cylindrical coordinates and Spherical coordinates.		
Unit – 4	**Number of lectures = 6**	**Title of the unit: Vector Integration**
Vector integration; line integration, Surface integration, Volume integration		
Unit – 5	**Number of lectures = 6**	**Title of the unit: Applications of theorems**
Statements and applications of Green's theorem, Gauss divergence theorem and Stokes theorem		

12. Books Recommended

1. Murrary R. spiegal: Theory end Problems of Advanced Calculus, Schaum Publishing Comp., New York.
2. Shanti Narayana: A Text Book of Vector Calculus. S. Chand & Co., New Delhi
3. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
4. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd. 2002.
5. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.

1. Name of the Department: Mathematics						
2. Course Name	Operations Research	**L**	**T**		**P**	
3. Course Code	09010628	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

Operations Research is a science of modeling and optimization. It allows you to model real-world problems by using mathematics, statistics, and computers. It provides you tools and theories to solve these real-world problems by finding the optimal solutions to the models subject to constraints of time, labor, resource, material, and business rules. With Operations Research, people make intelligent decisions to develop and manage their processes.

9. Course Objectives:

This module aims to introduce students to use quantitive methods and techniques for effective decisions making; model formulation and applications that are used in solving decision making problems.

10. Course Outcomes (COs):

On successful completion of this course, students will be able to:

1. Formulate and solve mathematical model (linear programming problem) for a physical situations like production, distribution of goods and economics.
2. Apply the concept of simplex method and its extensions to dual simplex algorithm.
3. Solve the problem of transporting the products from origins to destinations with least transportation cost.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Linear Programming**

Operations research and its scope, Necessity of operations research in industry. Linear programming problems Formulation and Graphical Solution.

Unit - 2	**Number of lectures = 6**	**Title of the unit: Simplex & Duality Theory**

Simplex method, Theory of simplex method, Big-M and Two Phase methods, Dual simplex method, Duality theory.

Unit - 3	**Number of lectures = 6**	**Title of the unit: Assignment Problem**

Initial basic feasible solutions of balanced and unbalanced assignment problems, Optimal solutions, multiple solutions & unbalanced assignment problems.

Unit - 4	**Number of lectures = 6**	**Title of the unit: Transportation Problem**

Initial basic feasible solutions of balanced and unbalanced transportation problems, multiple solution & Optimal solutions.

Unit - 5	**Number of lectures = 6**	**Title of the unit: Convex Sets & Sequencing**

Convex sets, Convex linear combination, convex hull, hyper plane, theorems on convex sets, Sequencing problems.

12. Books Recommended

1. Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004).
2. Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).
3. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi.
4. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
5. Taha H.A., Operations Research-An Introduction, PHI (2007)

1. Name of the Department: Mathematics						
2. Course Name	Complex Analysis	**L**	**T**		**P**	
3. Course Code	09010629	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 0**		**Practicals: 0**		

8. Course Description:

This course is aimed to provide an introduction to the theories for functions of a complex variable. Topic covers: Complex numbers and their algebraic, geometric and topological structures, concepts of analyticity, Cauchy-Riemann relations and harmonic functions, complex integration and complex power series, calculus of residues in the evaluation of integrals etc

9. Course Objectives:

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.

10. Course Outcomes (COs):

After completing this course, students will be able to:

1. Becoming familiar with the concepts Complex numbers and their properties and operations with Complex number.
2. Finding domain and range of complex functions and sketching their graphs.
3. Evaluating limits and checking the continuity of complex function.
4. Checking differentiability and Analyticity of functions.
5. Evaluate Complex integrals and applying Cauchy integral.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Exponential, Logarithmic and Hyperbolic Functions**
Functions of Complex Variable: Definition, Exponential function, Trigonometric and Hyperbolic functions, Logrithmic functions.		
Unit - 2	**Number of lectures = 6**	**Title of the unit: Continuity and Differentiability**
Limit and Continuity of a function, Differentiability and Analyticity, Cauchy-Riemann equations		
Unit - 3	**Number of lectures = 6**	**Title of the unit: Analytical Functions and their properties**
Analytical function, necessary and sufficient conditions for a function to be analytic, polar form of the Cauchy-Riemann equations.		
Unit – 4	**Number of lectures = 6**	**Title of the unit: Complex Integration and Power Series**
Harmonic functions, application to flow problems. Integration of complex functions, Cauchy Integral theorem and formula, Power series, radius and circle of convergence, Taylor's Maclaurin's and Laurent's series, Zeroes and singularities of complex functions, Residues.		

Unit-5	Number of lectures = 6	Title of the unit: Evaluation of Real Integrals
Evaluation of real integrals using residues (around unit and semi circle only).		

12. Books Recommended

1. Ruel V. Churchill and James W. Brown: Complex Variables& Applications. New York McGraw Hill, 4th Edition, 1984.
2. Murray R. Spiegel: Schaum's Outline Series: Theory and Problems of Complex Variables.
3. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
4. Joseph Bak and Donald J. Newman, Complex analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

1. Name of the Department: Mathematics						
2. Course Name	Computer Fundamentals	**L**	**T**		**P**	
3. Course Code	09010630	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

If you are a high-end computer user at home or college considering a career in information technology, or interested in furthering your knowledge about personal computers, the CompTIA® IT Fundamentals™ course is the first step in your preparation. In this course, you will identify PC components, work with files and folders, and conduct basic software installations. This course will provide you with the fundamental skills and concepts required to maintain, support, and work efficiently with personal computers. In addition, you will acquire the essential skills and information you need to set up, configure, maintain, troubleshoot, and perform preventative maintenance of the hardware and software components of a basic personal computer workstation and basic wireless devices. You will also implement basic security measures and implement basic computer and user support practices.

9. Course Objectives:

The course is designed to aim at imparting a basic level appreciation programme for the common man. After completing the course the incumbent is able to the use the computer for basic purposes of preparing his personnel/business letters, viewing information on Internet (the web), sending mails, using internet banking services etc. This allows a common man or housewife to be also a part of computer users list by making them digitally literate. This would also aid the PC penetration program. This helps the small business communities, housewives to maintain their small account using the computers and enjoy in the world of Information Technology.

10. Course Outcomes (COs):

Upon successful completion of this course, students will be able to perform

1. Set up a basic workstation, including installing basic hardware and software and establishing basic network connectivity; identify and correct compatibility issues, identify and prevent basic security risks; and practice basic support techniques on computing devices.
2. Identify hardware commonly found in or attached to computing devices.
3. Identify software commonly installed on computing devices.
4. Set up a basic workstation and configure network access.
5. Work with files, folders, and applications.
6. Configure and use wireless devices and secure computing devices.
7. Support computers and users.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: An overview of Computer System and its components**

Computer: Definition, Characteristics of Computers, Basic Applications of Computer(Sports, Research, Education, Business, Medicines & Health Care, Weather Forecasting, Military), Generations of computers, Number System.

Components of Computer System: Central Processing Unit (CPU), input/output Devices, computer Memory: primary and secondary memory, magnetic and optical storage devices, Concepts of Hardware and Software.

Unit - 2	Number of lectures = 6	Title of the unit: Input/Output and hard copy Devices

Input/Output Devices: Punched cards, card-readers, key-punching machines, keyboards, mouse, joysticks, trackballs, digitizer, voice-recognition, optical-recognition, scanners, terminals, point-of-sale terminals, machine-vision systems.

Hard-copy devices: Print quality, Impact printers - DMPs, Daisy-wheel printers, Line-printers, Drum printers, Chain printers; Non-impact printers - Inkjet, Laser, Thermal, LED; Plotters. Soft-copy devices: monitors, video-standards (VGA and SVGA).

Unit - 3	Number of lectures =6	Title of the unit: System software and Computer Network

Basic Introduction to system software:- Machine language, Assembly language, Low level languages, High level language, Compiler , Interpreter, Linker, Loader, Relationship between Compiler, Interpreter, linker, Loader.

Basic Introduction to Computer Networks: - Computer Network concepts, Topologies- Bus, Star, Ring, Tree, Hybrid, Types of Network- LAN, MAN, WAN.

Unit - 4	Number of lectures = 6	Title of the unit: Operating System

Software and Operating System Concepts: Introduction, Software Types, Language translators, System Utility Software, Application Software; Operating System – Characteristics, its functions, and its classification; User Interfaces – CUI and GUIs. DOS and Windows operating systems.

Unit - 5	Number of lectures = 6	Title of the unit: Internet and social Concerns

Internet Basics: Concept of Internet, Application of Internet, WWW, Web-sites and URLs, Search Engine, Using Electronic mails, Instant Messaging, Web Browsing software, Surfing the Internet.

Social Concern: Positive and Negative Impacts of Computer Technology, Computer Crimes, Computer Virus: Definition, Types of viruses, Characteristics of viruses, anti-virus software.

12. Books Recommended

1. Nasib Singh Gill: Handbook of Computer Fundamentals, Khanna Books Publishing Co.(P) Ltd., New Delhi, 2016.
2. P.K Sinha: Computer Fundamentals, BPB Publications.
3. Nasib Singh Gill: Computing Fundamentals and Programming in C, Khanna Books Publishing Co.(P) Ltd., New Delhi.
4. V. Rajaraman: Fundamentals of Computers, PHI
5. Norton Peter: Introduction to Computer, McGraw-Hill.
6. Leon, Alexis & Leon, Mathews: Introduction to Computers, Leon Tech World.
7. C.S. French: Data Processing and Information Technology, BPB Publications. Computer Networks (4th Edition), byAndrew S. Tanenbaum.
8. Essential of Computer & Network Technology by N S Gill, Khana book Publication.