Enclosure – IIIA

B. Sc. MATHEMATICS

SEMESTER – I			
19UMTCC101	**CORE 1: Differential Calculus**	**4hrs/wk**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Verify the existence of limits and calculate the limit, if exists, of single variable function and utilize the concept of limit to verify the continuity of single variable function.
2. Compute the higher order derivatives of given functions.
3. State and prove Leibnitz rule and implement the rule to compute the n^{th} derivative of given functions.
4. Apply the L'Hospital's rule for limits to calculate the limit of function of single variable.
5. Obtain the series expansion of a given function.
6. Establish the relation between curvature and radius of curvature and, evaluate the radius of curvature of any curve.
7. Determine the asymptotes, point of inflexions, concavity, convexity and the singular points.

Unit 1: Limit and continuity of functions of one variable (9hrs)

- Limit and continuity.
- Properties of limits.
- Properties of continuous function.
- Discontinuity.

Unit 2: Successive differentiation (10 hrs)

- Successive differentiation
  $e^{(ax+b)},\ a^{bx},\ (ax+b)^m,\ \log(ax+b),\ \sin(ax+b),\ \cos(ax+b),$
  $e^{ax}\sin(bx+c),\ e^{ax}\cos(bx+c)$
- Leibnitz's theorem and its applications.

Unit 3: Mean value theorems and Taylor's theorem (10 hrs)

- Mean value theorems and its geometrical interpretations.
- Increasing and decreasing functions.
- Expansion of functions using Taylor's Series and Maclaurian's series
- Expansions of standard functions, method of inversion.
- Expansion of a function by method of differentiation or integration.
- Method of expansion of implicit function by Maclaurian's series.

Unit 4: Indeterminate Forms (9 hrs)

- Indeterminate Forms including $\frac{0}{0}$, $\frac{\infty}{\infty}$, $0\times\infty$, $\infty-\infty$, 0^0 ,∞^0 ,1^∞
- L' Hospitals Rules for above indeterminate forms.

Unit 5: Curvature, asymptotes and multiple points (10 hrs)

- Various formulae for curvature (formulae for Cartesian coordinates, parametric equations and Polar coordinates only).
- Newton's method for curvature at origin.
- Concavity, Convexity and point of inflexion.
- Asymptotes parallel to co-ordinate axes.
- Oblique type and algebraic methods.
- Rules for finding asymptotes.
- Multiple points, Types of double points.

TEXT BOOKS: -

1. Shanti Narayan and P.K.Mittal, (2007), Differential Calculus, S. Chand & Company Ltd.
2. Dr. Gorakh Prasad, (2016), Text Book on Differential Calculus, Pothishala Pvt Ltd.

REFERENCE BOOKS:-

1. James Stewart, (2009), Calculus, 6th Edition,Brooks Cole.
2. M. J. Strauss, G. L. Bradley and K. J. Smith, (2007), Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi,.
3. S. C. Arora and Ramesh Kumar, (2006), A Text book of Calculus, Pitamber Publishing Company Ltd. Delhi.

Semester – I			
19UMTCC102	**CORE 2: Matrix Algebra**	**4hrs/wk**	**4 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Define and utilize the concept of matrix,
2. Understand the concept of Rank of a matrix and compute the rank of a given matrix.
3. Solve the systems of linear equations using concept of matrix and elementary row operations,
4. Understand and utilize the elementary row to obtain echelon forms of given matrix.
5. Find eigen value, eigen vector and characteristic equation of a matrix.
6. Compute any power of a given matrix.

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Unit 1: Concept of a matrix (10 hrs)

- Introduction to matrices, different types of matrices.
- Operations on matrices.
- Theorems on matrices.
- Elementary operations on matrices and types of matrices.
- Symmetric and skew -symmetric matrices.
- Hermitian and skew - Hermitian matrices.
- Adjoint of a matrix.
- Inverse of a matrix.

Unit 2: Rank and determinant of a matrix (10 hrs)

- Linear dependence and independence of row and column matrices.
- Row rank, column rank and rank of a matrix.
- Row Reduced Echelon form of a matrix and matrix inversion using it
- Determinant of a matrix and rank using it.
- Properties of determinant.

Unit 3: Cayley-Hamilton theorem (9 hrs)

- Eigen values, Eigen vectors and the characteristic equation of a matrix.
- Cayley-Hamilton theorem and its use in finding inverse of a matrix.

Unit 4: Application of matrices (9 hrs)

- Application of matrices in solving a system of simultaneous linear equations.
- Theorem of consistency of system of simultaneous linear equations.
- Gauss elimination method.
- Gauss Jordan method.
- Cramer's rule.

Unit 5: Diagonalization of a matrix and power matrix (10 hrs)

- Similar matrices- Definition and properties.

- Diagonalizable matrix.
- Diagonalization of Symmetric and Hermitian matrices.
- To find power of a matrix by using Diagonalization.
- To find power of a matrix by using Cayley-Hamilton Theorem.

TEXT BOOKS: -

1. Shanti Narayan and P.K. Mittal, (1953), ATextbook of Matrices, 11th Edition, S.Chand and Company Ltd.
2. N.Saran and J.K.Goyal, (2010), Introduction to Matrices, 20th Edition, PragatiPrakashan.

REFERENCE BOOKS:-

1. David C. Lay,(2007), Linear Algebra and its Applications, 3rd Edition, Pearson Education Asia, Indian Reprint.
2. Howard Anton and Chris Rorres, (2014), Elementary Linear Algebra, 11th Edition, Wiley.
3. Seymour Lipschutz and Marc Lars Lipson,(2013), Linear Algebra(Schaum's Outline Series), 6th Edition, McGraw Hill Education.
4. V. Krishnamurthy, V. P.Mainra and J. L.Arora, (1938), Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd.-New Delhi.

Semester – I			
19UMTCC103	**CORE PRACTICAL 1: Practical on Differential Calculus**	**6hrs/wk**	**2Credits**

Objectives: -

Upon completion of the course students will be able to

1. Understand the domain and range of given functions including polynomials, and hyperbolic functions and plot graph of the same using those domain and range.
2. Utilize the Leibnitz rule to compute the n^{th} derivative of given functions.
3. Implement the L'Hospital's rule for limits to calculate the limit of function of single variable.
4. Verify the Mean Value Theorems for given real valued function in given domain.

List of Practical

1. Plotting of graphs of function of type the greatest integer function, even and odd positive integer.
2. Plotting of graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Plotting of graphs of Hyperbolic functions.
4. Examples based on successive differentiation and applications of Leibnitz theorem.
5. Examples based on L'Hospital rule.
6. Expansions of functions in infinite power series using Taylor's and Maclaurin's formula.
7. Problems based on mean value theorem.
8. Problems based on Radius of curvature.
9. Problems based on Asymptotes.
10. Problems based on multiple points.

TEXT BOOKS: -

1. Shanti Narayan and P.K.Mittal, (2007), Differential Calculus, S. Chand & Company Ltd.
2. Dr. Gorakh Prasad, (2016), Text Book on Differential Calculus, Pothishala Pvt Ltd.

Semester – I			
19UMTCC104	**CORE PRACTICAL 2: Practical on Matrix Algebra**	**6hrs/wk**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the Cayley-Hamilton theorem.
2. Utilize the Cayley-Hamilton theorem to find the inverse of the given matrix.
3. Utilize direct methods including Gauss elimination method, Gauss Jordan method to solve the system of linear equations.
4. Understand and utilize methods of the Cramer's rule to solve the system of linear equations.
5. Find any power of a matrix by Diagonalization and Cayley Hamilton theorem.

List of Practical

1. Find Row Reduced Echelon form and rank of a matrix.
2. Solve the system of simultaneous linear equation by using Gauss elimination method.
3. Solve the system of simultaneous linear equation by using Gauss Jordan method.
4. Find inverse of a matrix by using Gauss Jordan method.
5. Solutions of system of linear equations using Cramer's rule.
6. Verify the Cayley-Hamilton theorem.
7. Find eigen value and eigen vector of a matrix.
8. Find inverse of a matrix by using Cayley-Hamilton theorem.
9. Find power of a matrix by using Diagonalization
10. Find power of a matrix by using Cayley-Hamilton Theorem.

TEXT BOOKS: -

1. K. B. Dutta, (2004), Matrix and Linear Algebra, Prentice Hall of India.
2. Shanti Narayan and P.K. Mittal, (1953), A Textbook of Matrices, 11th Edition, S.Chand and Company Ltd.
3. N.Saran and J.K.Goyal, (2010), Introduction to Matrices, 20th Edition, PragatiPrakashan.

Semester – II			
19UMTCC201	**CORE 3: Differential Equations**	**3 hrs-Theory/wk 2 hrs-Tutorial /wk**	**3 Credits**

Objectives: -

Upon completion of the course students will be able to

1. Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations, define and formulate a differential equation from a given relation or physical situations.
2. Define, identify and solve the differential equations of first order and first degree including Bernoulli's differential equation and First Order Exact differential equation.
3. Define, identify and solve differential equations of first order and higher degree.
4. Define, identify and solve Linear differential equations of higher order.

Unit 1: Differential Equations of First Order and First Degree: (10 hrs)

- Introduction-definition, order, degree and formation of a differential equation.
- Methods to solve separable equations, Homogenous equations, Bernoulli's differential equations, Exact differential equations.

Unit 2: Differential equations of first order and higher degree: (9 hrs)

- Differential equations of first order and first degree
  - Solvable for x.
  - Solvable for y.
  - Solvable for p.
- Lagrange's form of differential equations.
- Clairaut's form of differential equations

Unit 3: Linear differential equations of higher order (10 hrs)

- Linear differential equations of higher order with constant coefficients.
- Operator D, Meaning of auxiliary equation.
- Roots of auxiliary equation and solution of auxiliary equation f(D)y = 0 for real roots and complex roots.
- Operator $\frac{1}{D}$ and meaning of $\frac{1}{f(D)}$.
- Solution of differential equations of the type f(D)y = X.
- Meaning of complimentary function(C.F.) and Particular integral(P.I.).
- Methods to obtain Particular integral(P.I.) when $X = e^{ax}$, $X = \sin(ax+b)$, $X = \cos(ax+b)$, $X = x^m$, $X = e^{ax}V$; where V=exponential/ linear/ trigonometric functions.

Unit 4: Linear Differential Equations with Variable Coefficients. (10 hrs)

- Method of solution of homogeneous linear differential equations.
- Equations reducible to homogeneous linear form. Legendre's linear equations.

- Method to find the particular integral,
- The symbolic function $f(\theta)$ and $1/f(\theta)$ Integral corresponding to a term of the form x^{α} in the second member.

Unit 5: Partial Differential Equations (9 hrs)

- Definition and derivation of a partial differential equation by the elimination of constant.
- Derivation of a partial differential equation by the elimination of an arbitrary function.

TEXT BOOKS: -

1. Dr. Nita. H. Shah, (2015), Ordinary and Partial Differential Equations- Theory and Applications, 2nd edition, Prentice Hall of India Pvt Ltd. (Unit – 1 to 5)
2. M. D. Raisinghania,(2017), Ordinary and Partial Differential Equations, 19th edition,S.Chand and Company Ltd. (Unit – 1 to 5)

REFERENCE BOOKS:-

1. Daniel A. Murray, (2012), Introductory Course in Differential Equations, University Press. (Unit – 1 to 5)

Semester – II			
19UMTCC202	**CORE 4: Advanced Calculus**	**3 hrs-Theory/wk 2 hrs-Tutorial /wk**	**4 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Verify the existence of limits and calculate the limit (if exist) of function of several variable.
2. Utilize the concept of limit to verify the continuity of function of several variables.
3. Verify the differentiability of function of several variables.
4. Compute the partial derivatives of given function of several variables.
5. State and prove Euler's Theorem and implement the same to compute problems related to the Euler's Theorem.
6. Establish relation between Beta and Gamma function.
7. Apply Duplication formula and Reduction formulae.

Unit 1: Limit continuity of function of several variable (10 hrs)

- Introduction to function of several variables.
- Rectangular and spherical neighborhood of a point in R^n.
- Limit of function of several variables.
- Concept of iterated limit, limit and path.
- Continuity of function of several variables.

Unit 2: Differentiability of function of several variables-I (9 hrs)

- Introduction to partial derivatives.
- Different notations and its geometric interpretation.
- Directional derivatives.
- Higher order partial derivatives and problems.
- Differentiability of function of two variables.
- Theorems on differentiability conditions and converses.

Unit 3: Differentiability of function of several variables-II (10 hrs)

- Chain rule for differentiability.
- Homogeneous functions, Euler's theorem for homogeneous functions of two variables.
- Extreme values of functions of two variables and its theorems.
- Taylor's theorem for function of two variables.

Unit 4: Beta & Gamma Functions **(9 hrs)**

- Beta and Gamma functions and relation between them.
- Value $\int_{-\infty}^{\infty} e^{-x^2} dx$ as gamma function.
- Statement of Duplication formula(Legendre's Formula.)

Unit 5: Reduction formula **(9 hrs)**

- Reduction formulae $\int_0^{\frac{\pi}{2}} \sin^m x dx$, $\int_0^{\frac{\pi}{2}} \cos^m x dx$, $\int_0^{\frac{\pi}{2}} \sin^m x \cos^n x dx$ $(m, n \in N)$.

TEXT BOOKS: -

1. J. P. Singh, (2015), Calculus, 2nd edition Ane Books Pvt. Ltd. (Unit – 1 to 4)
2. Shanti Narayan and P.K. Mittal,(2006), Integral Calculus, S. Chand and Company Ltd.(Unit - 5)

REFERENCE BOOKS:-

1. David V. Widder, (1973), Advanced Calculus, Prentice Hall of India Pvt Ltd. (Unit – 1 to 4)
2. Shanti Narayan and P.K. Mittal,(2007), Differential Calculus, S. Chand & Co. (Unit – 1 to 4)

Semester – II			
19UMTCC203	**CORE PRACTICAL 3: Practical on Differential Equations**	**4 hrs/wk**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations, define and formulate a differential equation from a given relation or physical situations.
2. Define, identify and solve the differential equations of first order and first degree including Bernoulli's differential equation and first order exact differential equations.
3. Define, identify and solve differential equations of first order and higher degree.
4. Define, identify and solve linear differential equations of higher order.

List of Practical

1. To derive the differential equation from the given relation between x and y.
2. Solve the differential equations of order 1 and degree 1 & also higher degree.
3. Solve the homogeneous differential equations.
4. Solve the non-homogeneous differential equations.
5. Solve the linear differential equations.
6. Solve the Bernouli's differential equations.
7. Solve the exact differential equations.
8. Solve the differential equations of higher order and degree 1 with constant coefficients.
9. Solve the differential equations of higher order and degree 1 with variable coefficients.
10. Find the orthogonal trajectories of the system of parabolas.

TEXT BOOKS: -

1. Dr. Nita. H. Shah,(2015), Ordinary and Partial Differential Equations- Theory and Applications, 2nd edition, Prentice Hall of India Pvt Ltd.

REFERENCE BOOKS:-

1. Frank Ayres,(1952), Theory and problems on Differential Equations, McGraw Hill Book Co., New York.

Semester – II			
19UMTCC204	**CORE PRACTICAL 4 : Introduction To GeoGebra**	**6hrs/wk**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand and utilize the interface of the software GeoGebra including the file, edit, view & options menus and various tools from the tool bar.
2. Obtain the skill to draw various geometric figures including lines, functions and conics.
3. Understand the concept and usage of the slider in GeoGebra.
4. Understand and use the futures of the input bar in order to draw various graphs and utilize the input bar to enter various ready-made commands of GeoGebra.

List of Practical

1. Introduction and practice of usage of the file, edit, view & options menus.
2. Introduction and practice of usage of the tools from the tool bar (including move, point & line).
3. Introduction and practice of usage of the tools from the tool bar (including polygon, circle & conics tools).
4. Introduction and practice of usage of the tools (including measurement tool, transformation tool & text tool).
5. Drawing of geometric shapes (including triangles, quadrilaterals, polygons, circles, etc).
6. Graphs of functions, straight line, polynomials, trigonometric, inverse trigonometric, conic sections (including circle, ellipse, parabola, hyperbola etc), using input bar and introduction to input commands.
7. Verification of important theorems of geometry, algebra and calculus using GeoGebra.
8. Practical Based on usage of slider.
9. Practical Based on usage of spreadsheet view including usage of plotting, functions using data from spreadsheet view.
10. Geometric constructions using various circle tools and reflect, rotate and translate tools.

TEXT BOOKS: -

1. Judith Hohenwarter and Markus Hohenwarter, (2011), Introduction to GeoGebra, International GeoGebra Institute.

REFERENCE BOOKS:-

1. Judith Hohenwarter and Markus Hohenwarter, (2012), The official manual of GeoGebra, International GeoGebra Institute.

SEMESTER – III			
19UMTCC301	**Core 5 : Fundamentals of Mathematical Analysis**	**3 hrs-Theory/wk 2 hrs-Tutorial/wk**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Define and utilize the sequence, Understand bounded sequence, convergence sequence. State and prove Bolzano-Weierstrass Theorem, Cauchy's General principle of convergence of sequence.
2. Define series of positive terms, Choose and apply tests for convergence of series including p-test, Comparison test, Cauchy's Root test, D'Alembert's Ratio test, Logarithmic Test, Raabe's test, Integral Test.
3. Define and analyze Partitions and Riemann sums, Understand Upper and lower R-integrals, R-integrability, and Properties of R-integrable function.
4. State, prove and apply the Fundamental theorem of integral calculus and Mean value theorem of integral calculus.
5. Define and analyse improper integrals, Integration of unbounded function with finite limit, comparison test for convergence at$a$ of $\int_a^b f dx$ and infinite range of integration.

Unit 1: Sequences **(10 hrs)**

- Sequences (Definition).
- Limit point of a sequence.
- Limits Inferior and Superior.
- Convergent Sequence.
- Non convergent sequence (Definition).
- Cauchy's General principle of convergence of sequence.
- Algebra of sequences.
- Important theorems.
- Monotonic sequences.

Unit 2: Infinite Series **(10 hrs)**

- Series of non-negative terms.
- Geometric series, p-test.
- Comparison test.
- Cauchy's Root test.
- D'Alembert's Ratio test.
- Raabe's test.
- Logarithmic Test.
- Alternating series.
- Convergence of power series.

Unit 3: Riemann Integral: **(9 hrs)**

- Partitions and Riemann sums.
- Upper and lower R-integrals.
- R-integrability.
- The integral as limit.
- Some classes of integrable functions.
- Properties of R-integrable function.

Unit 4: Fundamental and Mean value theorem of integral calculus (9hrs)

- Derivability of the integral functions.
- Fundamental theorem of integral calculus.
- Mean value theorem of integral calculus.

Unit 5: Improper Integral: (10 hrs)

- Introduction.
- Integration of unbounded function with finite limit of integration.
- Comparison test for convergence at a of $\int_a^b f dx$.
- Infinite range of integration.

TEXT BOOKS: -

1. S. C. Malik and Savita Arora, (2017), Mathematical Analysis, New Age International(P) Ltd, Publishers, 2nd Edition.
2. S. C. Malik, (2006), Principles of Real Analysis, New Age International (P) Ltd, Publishers, 2nd Edition.

REFERENCE BOOKS:-

1. Shantinarayan, (2013) , A course of Mathematical Analysis, S. Chand & Sons.
2. Richard R. Goldberg, (1976), Methods of Real Analysis, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
3. Walter Rudin, (2017), Principle of Mathematical Analysis, MC Graw-Hill Book & Company, 2nd Edition.

Semester – III			
19UMTCC302	**Core 6 :Linear Algebra**	**Theory-3 hrs/week Tutorial-2 hrs/wk**	**4 Credits**

Objective:

Upon completion of the course students will be able to

1. Understand and define the concept of a vector space.
2. Understand and define the concept of linear combination and span and subspace
3. Solve the problems based on linear combination and span and subspace.
4. Understand, identify and critically analyze the linear dependence and independence of vectors, basis of a vector space, dimension of vector space.
5. Solve the problems based on linear dependence and independence of vectors, basis of a vector space, dimension of vector space.

Unit 1:Concept of a Vector space: (10 hrs)

- Introduction of Vector space and vectors in R^n & C^n.
- Definition of a Field
- Definition of Vector space.
- Examples of Vector space.
- Properties of Vector space.

Unit 2: Linear Combination and Span (10 hrs)

- Concept of Linear combination and its examples.
- Concept of span and its examples.
- Linearly dependence of vectors.
- Linearly independence of vectors.
- Theorem and Examples based on linearly dependence and independence.

Unit 3: Subspace and related topics (7 hrs)

- Concept of Subspaces.
- Theorem related to subspaces.
- Sum and Direct sum of subspaces and their examples.
- Complementary subspace, Disjoint subspace, Quotient space.

Unit 4: Basis and Dimension of a Vector space (10 hrs)

- Basis of a vector space.
- Invariance of the number of the elements of a basis set.
- Examples and theorem of basis.
- Definition of a dimension of Vector space.
- Dimension of sum of subspaces.
- Example & Theorem based on dimension.

Unit 5: Linear Transformation: (7 hrs)

- Concept of Linear Transformation, Zero and Identity Linear Transformation.
- Theorems on Linear Transformation.
- Range and Kernel of Linear Transformation
- Rank-Nullity theorem.
- Matrix associated with a linear map and linear map associated with a matrix.

TEXT BOOKS:

1. I. N. Herstein, (1975), Topics in Algebra, John Wiley & Sons, New York
2. Seymour Lipschutz, (1989), Scham's Solved Problem Series in Linear Algebra, McGraw-Hill Book Company.

REFERENCE BOOKS:

1. S. Kumaresan, (2004), Linear Algebra(A Geometrical Approach), PHI learning Pvt. Ltd. New Delhi.
2. V. Krishnamurthy, V.P. Mainra, & J. L. Arora, (2001), An Introduction to Linear Algebra, East-West Publications Pvt. Ltd.
3. Serge Lang, (2000), Introduction to Linear Algebra (2^{nd} Edition), Springer Publication.
4. David C. Lay, (2006), Linear Algebra & Its Applications, Addition Wesley Publishing Company.

Semester – III			
19UMTCC303	**Core Practical 5:** **Practical on Numerical Methods.**	**6 hrs/wk.**	**2 Credits**

Objectives: -

Upon completion of the course students will be able to

5. Find numerical approximations to the roots of an equation by sketching the graph.
6. Find numerical approximations to the roots of an equation by Newton-Raphson's method, Bisection Method, Secant Method, False position method, Iteration method, Ramanujan's method
7. Find square root and cube root of ant positive integer by applying Newton-Raphson's method.
8. Find value of derivative of polynomial at a point by synthetic division method.
9. Find approximate root of a polynomial equation by Horner's method.

List of Practical

1. Solution of algebraic and transcendental equation by Graphical method.
2. Solution of algebraic and transcendental equation by Bisection method.
3. Solution of algebraic and transcendental equation by secant method.
4. Solution of algebraic and transcendental equation by False position method (Regula Falsi Method).
5. Solution of algebraic and transcendental equation by Iteration method.
6. Solution of algebraic and transcendental equation by Newton-Raphson's method.
7. Applications of Newton-Raphson's method.
8. Derivatives of a polynomial by synthetic division method.
9. Transformation of equations.
10. Derivatives of a polynomial by synthetic division method.
11. Horner's method for solving polynomial equation.

TEXT BOOKS: -

1. S.S. Sastry, (2012), Introductory Methods of Numerical Analysis, PHI Learning Private Limited, New Delhi.
2. S.R.K. Iyengar and R.K. Jain, (2009), Numerical Methods, New Age International Publishers, New Delhi.

Semester – III			
19UMTCC304	**Core Practical 6 : Introduction to Scilab.**	**6 hrs/week**	**2 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the concept of open source mathematical software including SCILAB.
2. Understand and utilize the user interface of SCILAB including console, file browser, variable browser, the command history and general commands including clc& clear
3. Utilize pre-defined mathematical constants and variables, operators of Scilab, Input and utilize inbuilt matrix commands including ones(), zeros(), eye(), spac(), diag(), inv(), det(), spec().
4. Plot graphs of mathematical functions including Cartesian form, parametric form and polar forms of equations
5. Perform matrix operation including operators +, -,*, /, \, :, ^ and over-loaded operators including .+, .-,*, ./, .\, .^, in Scilab.
6. Find and analyse the sub matrices of given matrices

List of Practical

1. Introduction to user interface of SCILAB including console, file browser, variable browser and the command history and general commands including clc, clear etc .

2. Introduction and practice of usage of the pre-defined mathematical constants and variables, operators including arithmetic operators and comparison operators, complex numbers, precedence of operators .

3. Inputting matrices including row vectors, column vectors, square matrix and rectangular matrix and processing those matrices. Inputting and utilizing inbuilt matrix commands including ones(), zeros(), eye(), spac(), diag(), inv(), det(). Practical based on matrix operation including +, -,*, /, \, :, ^ and over-loaded operators including .+, .-,*, ./, .\, .^,

4. (i) Finding sub-matrices including the cofactors, minors, adjoint.
(ii)To find inverse of a matrix using adjoint of a matrix.

5. (i)To draw the graph of circle. (iii) To draw the graph of ellipse.
(ii) To draw the graph of parabola (iv) To draw the graph of hyperbola.

6. To draw the graph of trigonometric functions.

7. To draw the graph of inverse trigonometric functions.

8. To draw the graph of sinh(x), cosh(x), tanh(x).

9. To draw the graph of coth(x), sech(x), cosech(x).

10. To draw the graph of exp(x), $\log_e(x)$, $\log_{10}(x)$.

TEXT BOOKS: -

1. Vinu V. Das, (2008), Programming in Scilab, New Age International (P) Limited.
2. Domaine de Voluceau - Rocquencourt – B, (2010), Introduction to Scilab Consortium Scilab.

REFERENCE BOOKS:-

1. Tejas Sheth, (2016), Scilab: A Practical Introduction to Programming and Problem Solving.
2. Perrine Mathieu, (2016), Philippe Roux, Scilab, from theory to practice, Scilab: I. Fundamentals, ISBN: 978-2-8227-0293-5
3. Dr. M. Affouf, (2012), Scilab by example, ISBN: 978-1479203444.

Semester – IV			
19UMTCC401	**Core 7 : Discrete Mathematics**	**4 hrs/week**	**4 Credits**

Objective:

Upon completion of the course students will be able to

1. Understand and utilize the fundamental concepts of Discrete Mathematics and understand and verify the different types of relations.
2. Identify and apply basic concepts of set theory, arithmetic, logic, proof techniques, and binary relations.
3. Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.
4. Understand and apply the concepts of Boolean Algebra and it forms.

Unit 1:Relations **(6 hrs)**

- Different types of relations.
- Binary relations, Equivalence relations and partitions.
- Partial order relations, Posets.
- Hasse diagram.
- Lattices as posets.
- Properties of lattices.

Unit 2: Lattices as algebraic systems **(6hrs)**

- Lattices as algebraic systems.
- Sub lattices.
- Direct product of two lattices.
- Homomorphism.
- Order isomorphism of two posets.
- Isomorphic lattices.

Unit 3: Some special Lattices **(6 hrs)**

- Complete lattices.
- Bounded lattices.
- Distributive lattices.
- Complemented lattices.

Unit 4:Boolean algebra **(10 hrs)**

- Definition and examples of Boolean Algebra.
- Direct product of two Boolean Algebra.
- Homomorphism.
- Atoms of Boolean Algebra.
- Stone's representation theorem.
- The set A(x) of all atoms of Boolean Algebra and its properties.
- Isomorphism of a finite of finite Boolean Algebra and $P(A)$.

Unit 5: Boolean expressions And Canonical forms **(8 hrs)**

- Boolean expressions.
- Minterms and Maxterms.
- Sum of product Canonical form.

- Product of sum Canonical form.
- Minimization of a Boolean expression by cube array representation.
- Boolean Algebra of switches and circuits.
- Karnaugh map.

TEXT BOOKS: -

1. J. R. Trembley and R. Manohar (2017), Discrete Mathematical Structures with applications to computer science, Macgraw-Hill International Editions.

REFERENCE BOOKS:-

1. L. Liu, Elements of Discrete Mathematics by Computer Science series, Macgraw-Hill International Editions, 1986 (2nd edition).
2. Vatsa(2013), Discrete Mathematics, Vikas Publications.
3. K. D. Joshi(2014), Foundation of Discrete Mathematics, New Age International Ltd. Publishers.
4. Dugragi(1998) ,Discrete Mathematics Structure, Narora Publications.
5. J.E.Whitesitt(1961),Boolean Algebra And its Application, Addison-Wesley Publishing Co.Inc.

SEMESTER – IV			
19UMTCC402	**Core 8: Integral and Vector Calculus**	**Theory-3 hrs/week Tutorial-1hrs/wk**	**3 Credits**

Objectives: -

Upon completion of the course students will be able to

1. Evaluate the double integral in general and polar co-ordinates as well.
2. Reverse the order of integration for a double integration.
3. Evaluate a triple integral to find volume in rectangular co-ordinates, cylindrical co-ordinates and spherical co-ordinates.
4. Evaluate the function using Laplace transform.
5. Identify proper method to solve any differential equation
6. Understand the difference between vector point function and scalar point function.

Unit 1: Double Integrals **(10hrs)**

- Introduction
- Double integrals over rectangles
- Properties of double integrals
- Double integrals over general region
- Double integrals in Polar co-ordinates
- Change of variable from Cartesian to polar co-ordinates

Unit 2: Triple Integrals **(10 hrs)**

- Introduction to Triple integrals
- Triple integrals in cylindrical co-ordinates
- Triple integrals in spherical co-ordinates
- Change of order of integration
- Jacobian of several variables

Unit 3: Laplace Transforms & Applications **(10 hrs)**

- Laplace Transform
- Properties of Laplace Transform
- Inverse Laplace Transform
- First Shifting theorem
- Laplace Transform of derivatives and integrals
- Differentiation and integration of Laplace Transform
- Convolution theorem

Unit 4: Vector Differentiation **(9 hrs)**

- Vector point functions
- Scalar point functions
- Vector Differentiation
- Laplace operator
- Gradient
- Divergence and curl

Unit 5: Vector Integration **(9hrs)**

- Line integral
- Green's theorem
- Surface integrals
- Gauss divergence theorem (without proof) and example
- Stoke'stheorem (without proof) and example

TEXT BOOKS: -

1. Shanti Narayan and P.K.Mittal, (2007), Differential Calculus, S. Chand & Company Ltd.
2. S. C. Malik and S. Arora (2009), Mathematical Analysis, New Age International(P) Ltd.

REFERENCE BOOKS:-

1. Shanti Narayan and P.K.Mittal, (2015), Intergral Calculus, S. Chand & Company Ltd.
2. S. C. Malik (2010), Principles of Real Analysis, New Age International (P) Ltd, Publishers, 2nd Edition.

Semester –IV			
19UMTCC403	**Core 9: Complex Variables and Inner Product Space.**	**Theory-3 hrs/ week Tutorial-1hrs/week**	**4 Credits**

OBJECTIVES:-

Upon completion of the course students will be able to-

1. Recognize and plot a complex number.
2. Carry out any of the arithmetic operations on complex numbers using either the rectangular form or the trigonometric form.
3. Compute and use the magnitude and the argument of a complex number to translate between the rectangular form and the trigonometric form of a complex number.
4. Compute the n^{th} power or root of a complex number using De Moivre's theorem, and graph the results.
5. Understand and verify the differentiability, continuity and limit of function of a complex variable.

Unit 1: Complex Numbers-Basic Concepts (4 hrs)

- Sums and products, Basic Algebraic properties.
- Modulii, complex conjugates.
- Argument of a complex number
- Exponential form.
- Products and quotients in exponential form

Unit 2: De' Moivre's theorem and its applications (8 hrs)

- De' Moivre's theorem.
- Applications of De'Moivre's theorem.
- Roots of a complex number.
- Expansion of $\cos n\theta, \sin n\theta, \tan n\theta$ in terms of $\cos\theta, \sin\theta, \tan\theta$

Unit 3: Elementary functions (9 hrs)

- The exponential function
- The Logarithmic function
- Branches and derivatives of logarithms
- Trigonometric functions
- Hyperbolic functions

Unit 4: Analytic Functions (10 hrs)

- Functions of a complex variable
- Limits, theorems on limits
- Continuity and derivatives
- Polar coordinates.
- Analytic functions in Cartesian and polar coordinates, examples
- Cauchy Reimann equations

- Sufficient condition for a function to be analytic

Unit 5: Inner Product Space **(9 hrs)**

- Inner product space-definitions and examples
- Norm of a vector in an inner product space.
- Cauchy Schwarz inequality.
- Orthogonal and orthonormal bases.
- Gram Schmidt process.

TEXT BOOKS: -

1. James Ward Brown and Ruel V. Churchill, (2014), Complex Variables and Applications, 9th ed., McGraw Hill Higher Education.
2. Shanti Narayan and Dr. P. K. Mittal, (1956), Theory of Functions of a Complex variable, S. Chand Publications.
3. Seymour Lipschutz and Marc Lars Lipson, (2009), Schaum's Outlines Linear Algebra, 4th ed.,McGraw Hill Book & Company.

REFERENCE BOOKS:-

1. James Ward Brown and Ruel V. Churchill, (2009), Complex Variables and Applications, 8th Ed., McGraw Hill International Edition.
2. Dennis G. Zill and Patrick D. Shanahan, (2003), A First Course in Complex Analysis with Applications, Jones and Bartlett Publishers, Inc.
3. Joseph Bak and Donald J. Newman, Complex Analysis, (2010),3rd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc.

Semester – IV			
19UMTCC404	**Core Practical 7 : Advanced GeoGebra**	**4 hrs/wk**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand and utilize the interface of the software GeoGebra including slider tools from the tool bar.
2. Obtain the skill to draw various geometric figures including lines, functions and conics.
3. Understand the concept and usage of the slider in GeoGebra.
4. Understand and use the futures of the input bar in order to draw various graphs and utilize the input bar to enter various ready-made commands of GeoGebra.

List of Practical

1. Advanced slider usage for problems involving Trigonometry and Geometry.
2. Advanced slider usage for problem involving Algebra and Calculus.
3. Further usage of sliders to make the figures interactive and verify theorems of Algebra, Geometry and Calculus.
4. Introduction and practice of usage of Animation in basic Geometric figures.
5. Introduction and practice of usage of Animation in Algebra, Trigonometry and Calculus.
6. Introduction to commands for Linear Algebra and its basic usage.
7. Advanced commands of input bar, advanced formatting using these commands and interactive usage these commands.
8. Introduction to construction of interactive worksheets of GeoGebra models based on mathematical concepts.
9. Practical to calculate statistical parameters including mean, median, mode and plotting bar chart, histogram etc, based on usage of spreadsheet and input bar.
10. Inserting and analysing pictures (of real life objects) and applying GeoGebra to find length, area, equation of curve, volume and other measurements.

TEXT BOOKS: -

2. Judith Hohenwarter and Markus Hohenwarter, (2011), *Introduction to GeoGebra,* International GeoGebra Institute.

REFERENCE BOOKS:-

2. Judith Hohenwarter and Markus Hohenwarter, (2012), *The official manual of GeoGebra*, International GeoGebra Institute.

Semester – IV			
19UMTCC405	**Core Practical 8: Introduction to MAXIMA**	**4 hrs/week**	**2 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the user interface and components of the software MAXIMA/ wxMAXIMA.
2. Utilize the software maxima to compute derivative and integration
3. Analyze the mathematical functions using commands of Maxima.
4. Plot the 2D and 3D graphs of mathematical functions using Maxima.
5. Determine the convergence and divergence of the given sequence and series using Maxima.

List of Practical

1. Introduction to the user interface and components of the software MAXIMA/ wxMAXIMA.
2. Introduction to the inbuilt constants variables and library functions of MAXIMA.
3. Utilizing the command for solution of linear equations, polynomial equations, system of linear equations.
4. Introduction to Maxima commands for calculus including commands for derivatives and nth derivatives, partial derivative.
5. Introduction to Maxima commands for calculus including commands for definite integration, indefinite integration, numerical integration.
6. Maxima commands for 2D and 3D plotting, including formatting of plotted figures. - Plotting of standard Cartesian curves using Maxima.
   -Plotting of standard Polar curves using Maxima.
   -Plotting of standard parametric curves using Maxima.
7. Solution of Differential equation using Maxima plotting the solution.
8. Maxima programs to find the series of function and sum of the series
9. Maxima programs to illustrate continuity of a function. Maxima programs to illustrate differentiability of a function and unequal left hand and right hand limits for discontinuous functions.
10. Evaluation of limits using Maxima.
11. Method of solving ordinary differential equations
12. Introduction to the MAXIMA commands and tools for Statistical calculation including commands for mean, median, variance, standard deviation, histogram, bar plot, pie chart etc.
13. Introduction to Maxima commands for matrices and determinants.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics). Any other mathematical software may also be used in place of Maxima.

TEXT BOOKS: -

1. Gurpreet Singh Tuteja, Practical Mathematics Using Maxima: An Open Source Computer Algebra System, IBH, 2010.
2. Zachary Hannan, wxMaxima for Calculus I and II, Solano Community College
3. Leon Q. Brin, Maxima (5.18.1) and the Cal
   ulus, 2010
4. Robert Dodier, Minimal Maxima, 2005.
5. Richard H. Rand, Introduction to Maxima, Cornell University
6. EleftheriosGkioulekas, Introduction to Maxima, University of Texas-Pan American , Edinburg, TX, United States
7. Edwin L. Woollett, Maxima by Example, August 11, 2009.
8. Paulo Ney de Souza, Richard J. Fateman, Joel Moses The Maxima Book, Cliff Yapp, 2003.

Semester – V			
19UMTCC501	**Core 10 : Group Theory**	**4 hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the basic ideas and notions of abstract algebra.
2. Define and recognize the abstract mathematical structures including group and subgroups.
3. State and criticize the properties of groups.
4. Define and recognize the Isomorphism groups and Homomorphism groups.
5. Define of Permutation groups and cyclic groups and prove theorems of the same.

Unit 1:Introduction to Group (6 hrs)

- Definition and examples of Groups.
- Elementary Properties of Group.
- Finite group, Order of a group, Order of an element.

Unit 2:Subgroups and Normal Subgroups (7 hrs)

- Definition and example of a subgroup.
- Lagrange's Theorem.
- Definition of Centre of a Group and theorems related to it.
- Definition and example of a Normal subgroup.
- Theorems related to Normal Subgroup.

Unit 3: Permutation Groups and Cyclic Group (8 hrs)

- Definition and examples of Permutation Groups.
- Transposition and Cycle.
- Properties of Cyclic Group.
- Classification of Subgroup of Cyclic Group.

Unit 4: Homomorphism of Groups (7 hrs)

- Definition and Examples
- Properties of Homorphisms
- Kernal of Homomorphism

Unit 5: Isomorphism of Groups (7 hrs)

- Definition and Examples
- Cayley's Theorem
- Properties of Isomorphism.
- Automorphisms and Inner Automorphisms.

TEXT BOOKS: -

1. I.H.Sheth, 2nd edition, (2003) , Abstract Algebra, Prentice/Hall of India Private Limited, New Delhi(Unit- 1 to5)

2. I. N. Herstein, (1975), Topics in Algebra, John Wiley & Sons, New York (Unit- 1 to5)

REFERENCE BOOKS:-

1. Thomas W. Judson, (2009), Abstract Algebra Theory and Applications, Stephen F. Austin State University.
2. Marlow Anderson & Todd Fel, (2005), A first course in Abstract Algebra (Rings, Groups & fields), Chrpman & Halilereivy,
3. Fraleigh J.B., (2003), A First Course in Abstract Algebra, Narosa Publishing, New Delhi.
4. Joseph A. Gallian, ForthEdition (2011), Contemporary Abstract Algebra, Narosa Publishing House. (Unit- 1 to5)

Semester – V			
19UMTCC502	**Core 11 : Fundamentals of Numerical Analysis**	**3Hrs/wk**	**3 credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze data and find proper curves to fit the data given.
2. Understand the meaning of roots and find the roots of given equations including Equation with Rational Coefficients and Irrational Roots.
3. Solve and criticize Simultaneous Linear Algebraic Equation.
4. Find finite differences and study of other difference operator.
5. Understand and analyze interpolation with equal interpolation.

Unit 1: Empirical Laws and Curve Fitting **(8 hrs)**

- Introduction.
- The Linear Law.
- Laws reducible to linear law
- Principle of Least Squares.
- Fitting a Straight Line.
- Fitting a Parabola.
- Fitting an Exponential Curve.
- Fitting the curve $y = ax^b$.

Unit 2: Theory of Equation. **(8 hrs)**

- Introduction.
- Relation between Roots and Coefficients.
- Equation with Real Coefficients and Imaginary Roots.
- Equation with Rational Coefficients and Irrational Roots.
- Symmetric Function of Roots.
- Formation of Equation whose Roots are Given.
- Transformation of Equation.
- Multiple Roots.

Unit 3: Simultaneous Linear Algebraic Equation. **(10 hrs)**

- Introduction.
- Gauss elimination method.
- Gauss Jordan method.
- Method of factorization (L.U. Decomposition).
- Crout's method.
- Jacobi's method of iteration.
- Gauss Seidal's iteration method.

Unit 4: Finite Differences. **(10 hrs)**

- Introduction.
- Finite differences (forward, backward and central).
- Differences of polynomials.
- Factorial polynomial.
- Reciprocal Factorial polynomial.
- Polynomial factorial notation.
- Error propagation in difference table.
- Other difference operators (Shift, averaging, differential and unit) and relation between them.

Unit 5: Interpolation with Equal Intervals. **(8 hrs)**

- Introduction.
- Gregory- Newton forward interpolation formula.
- Gregory- Newton backward interpolation formula.
- Equidistance terms with one or more missing values.

TEXT BOOKS: -

1. Numerical methodsby Dr. V. N. Vedamurthy& Dr. N. Ch. S. N. Iyengar, (1998) Vikas Publishing house.

REFERENCE BOOKS:-

1. M. K. Jain, S. R. K.Iyengar, R. K. Jain (1996) Numerical method, Problems & Solutions, by, New Age International Pvt. Ltd
2. J. B.Scarforough,(1966) Numerical Mathematical Analysis, Oxford & IBH Publi. Co. Pvt. Ltd.,

SEMESTER – V			
19UMTCC503	**Core 12 : Introduction to C**	**4 hrs/week**	**4 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze given mathematical problem to solve it using a computer program.
2. Develop algorithm to solve given mathematical problem using C program.
3. Write program to solve given mathematical problem using it.
4. Find errors in the C program and correct it.

Unit 1: Introduction to C **(8hrs)**

- History of C, C character set
- Constants, Variables, Keywords, Type Declaration, Type Conversion
- Hierarchy of operators
- printf & scanf functions
- Simple programs using these basic concepts.

Unit 2: Decisions and Branching **(7hrs)**

- if statement, if-else statements
- Nested if-else, elseif clause
- Logical operators, Conditional operators
- Programs using these concepts

Unit 3: Looping Mechanism and User Defined Functions **(7hrs)**

- While loop, for loop
- do-while loop, break statement
- Continue statement, goto statement
- Brief introduction to User Defined Functions
- Programs using these concepts

Unit 4: Data types and Preprocessor **(7hrs)**

- Data types in C Integers: long and short types
- signed and unsigned characters, Signed and unsigned
- float and doubles
- C processors, meaning
- Macro Expansion
- Macros with Arguments
- Programs using these concepts

Unit 5: Introduction to Arrays **(7hrs)**

- Arrays, meaning:
- One dimensional and two dimensional
- Declaration and initialization of one dimensional and two dimensional arrays

- Use of one dimensional and two dimensional arrays in simple programs

TEXT BOOKS: -

1. Yashvant Kanetker, (2016), LET US C, 5th Edition, BPB Publications, New Delhi.
2. E. Balagurusamy, (2017), Programming in ANSI C, McGrew Hill Education, Seventh Edition.

REFERENCE BOOKS: -

1. Brian W. Karnighan and Dennis M. Ritchie, (1988), The ANSI C Programming Language,
Prentice Hall.
2. V. Rajaraman, (1994), Computer Programming in C, Prentice Hall of India.

SEMESTER – V			
19UMTCC504	**Core 13 : Set theory and Logic (Self study course)**	**1 hrs/wk**	**4 Credits**

Objectives: -

Upon completion of the course students will be able to

1. Analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.
2. Construct truth tables, prove or disprove a hypothesis,
3. Evaluate the truth of a statement using the principles of logic.
4. Solve problems and write proofs using the concepts of set theory, including the methods of Venn diagrams and truth tables.

Unit 1: Sets and Basic operations on sets (3 hrs)

- Preliminaries: Basic set theory terminology and notation
- Venn Diagrams
- Classes of sets and power set
- Set operations
- Mathematical Induction
- Real Number System R
- Order and Inequalities, Absolute value, Distance, Intervals
- Bounded sets
- Integers Z, Greatest Common Divisor

Unit 2: Cardinal and Ordinal numbers (2 hrs)

- Denumerable and Countable sets
- Cardinal Numbers, Ordering of Cardinal Numbers
- Cardinal Arithmetic
- Well Ordered sets
- Ordinal Numbers, Structure of Ordinal Numbers

Unit 3: Functions and Relations (3 hrs)

- Product set, Relations-introduction
- Composition of relation, Types of relation
- Functions-Introduction
- Composition of functions
- One to one, onto and invertible function
- Mathematical functions- exponential, logarithmic function

Unit 4: Special Functions and Algorithms (2 hrs)

- Operations of Collections of sets
- Indexed of Collections of sets
- Sequences, Summation symbol

- Fundamental Products
- Functions and Diagrams
- Special kinds of functions, Fundamental Factorization
- Choice function
- Algorithms and functions
- Complexity of Algorithms

Unit 5: Logic and Truth Tables (2 hrs)

- Logic propositions: Truth and falsehood of propositions,
- Tautologies and Contradictions
- Logic operations
- Logical equivalence, Equivalences for negations, Equivalent forms of the implications
- Circuits and Logic

TEXT BOOKS: -

1. Robert R. Stoll (1963), Set Theory and Logic, Dover Publications, New York.
2. Karel Hrbacek and Thomas Jech (1999), Introduction to Set Theory, Marcel Dekker.

REFERENCE BOOKS:-

1. Ernest Schimmerling (2011), A Course on Set Theory, Cambridge University Press.
2. Seymour Lipschutz (1988), Set Theory and Related Topics, 2nd edition, Schaum's Outline Series, McGraw Hill..

Semester – V			
19UMTCC505	**Core Practical 9 : Programming in C.**	**4hrs/week**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze given mathematical problem to solve it using a computer program.
2. Develop algorithm to solve given mathematical problem.
3. Write C program to solve given mathematical problem using the program.
4. Find errors in the C program and correct it.

List of Practical

1. Write a program to find area of a circle when radius is given.
2. Write a program to calculate the area of a triangle when base and height of the triangle are given.
3. Write a program to find value of one number raised to another number.
4. Write a program to determine whether given number is an even or odd number.
5. Write a program to find largest of three given numbers.
6. Write a program to find largest of four given numbers.
7. Write program to find net salary when basic salary and other required details are given.
8. Write a program to solve the quadratic equation
9. Write a program to reverse an integer with FIVE digits.
10. Write a program to verify a number whether it is palindrome or not.
11. Write a program to find sum of the digits an integer with FIVE digits.
12. Write a program to print Armstrong numbers between1 to 999.
13. Write a program to generate arithmetic and geometric progressions.
14. Write a program to find nPr and nCr for given value of +ve integers n and r.
15. Write a program to find compound interest for given years.
16. Write a program to find number of odd number and even numbers.
17. Write a program to find factorial of a given number.
18. Write a program using UDF with two arguments and a return value.
19. Write a program that utilizes a UDF two find prime numbers between two integers entered through key-board.
20. Write a program to solve the equation by N-R method. (Use of preprocessor)
21. Write a program to find value determinant of a 2X2 and a 3X3 matrix.
22. Write a program to find inverse of a 2X2 matrix.
23. Write a program to find diagonal of a 3X3 matrix entered through key-board.
24. Write a program to find the sum, deference, and multiplication of two 3X3 matrices entered through key-board.

TEXT BOOKS: -

1. Yashvant Kanetker, (2016), LET US C, 5th Edition, BPB Publications, New Delhi.
2. E. Balagurusamy, (2017), Programming in ANSI C, McGrew Hill Education, Seventh Edition.

REFERENCE BOOKS:-

1. Brian W. Karnighan and Dennis M. Ritchie, (1988), The ANSI C Programming Language, Prentice Hall.
2. V. Rajaraman, (1994), Computer Programming in C, Prentice Hall of India.

Semester – V			
19UMTCC506	**Core Practical 10 : Practical on Fundamentals of Numerical Analysis**	**4hrs/week**	**2 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Analyze data and find proper curves to fit the data given.
2. Understand the meaning of roots and find the roots of given equations including Equation with Rational Coefficients and Irrational Roots.
3. Solve and criticize Simultaneous Linear Algebraic Equation.
4. Find finite differences and utilize the same to do interpolation of given data.

List of Experiments

1. Gauss elimination method.
2. Gauss Jordan method.
3. LU decomposition method.
4. Crout's method.
5. Jacobi's method.
6. Gauss Seidel method.
7. Fitting a Straight line.
8. Fitting an exponential curve $y = e^{ax}$.
9. Fitting a Parabola.
10. Fitting the curve of the type $y = ax^b$.
11. Finite differences.
12. Gregory- Newton forward interpolation formula.
13. Gregory- Newton backward interpolation formula.
14. Equidistance terms with one or more missing values.

TEXT BOOKS: -

1. Numerical methods by Dr. V. N. Vedamurthy& Dr. N. Ch. S. N. Iyengar, Vikas publishing house.

REFERENCE BOOKS:-

1. Introduction to Numerical Analysis (2nd Edition) by C.E.FrobergAddisionWasley, 1979.
2. Numerical method, Problems & Solutions, by M. K. Jain, S. R. K.Iyengar, R. K. Jain, New Age International Pvt. Ltd., 1996.
3. Numerical Mathematical Analysis, by J. B.Scarforough, Oxford & IBH Publi.Co. Pvt. Ltd., 1966.

Semester – V			
19UMTCC507	**Core Practical 11 : Advanced SCILAB**	**3 hrs/week**	**2 Credits**

Objectives:

Upon completion of the course students will be able to

1. Understand the concept of open source mathematical software including SCILAB.
2. Understand and utilize the user interface of SCILAB including console, file browser, variable browser, the command history and general commands including clc& clear
3. Utilize pre-defined mathematical constants and variables, operators of Scilab, Input and utilize inbuilt matrix commands including ones(), zeros(), eye(), spac(), diag(), inv(), det(), spec().
4. Solve problems using direct and iterative methods of numerical analysis with scilab.
5. Find and analyze the sub matrices of given matrices

List of Practical

1. To get understand and utilize the program editor SCINOTE and its interface with small programs.
2. To create programs in SCINOTE understand usage of commands including clear, clear all, clf, clc, etc.
3. To find the inverse of a matrix using GAUSS-ELIMINATION method.
4. To find inverse of given matrix using GAUSS-JORDAN method.
5. To find Eigen values and Eigen vectors of given matrix.
6. To find inverse of given matrix using CAYLEY-HAMILTON theorem.
7. To solve given system of simultaneous linear algebraic equations using GAUSS-JORDAN method.
8. To solve given system of simultaneous linear algebraic equations using GAUSS-JACOBI method.
9. To solve given system of simultaneous linear algebraic equations using GAUSS-SEIDAL'S method.
10. Introduction to variables and input statement in SCILAB, Introduction to the loop structure of SCILAB.

TEXT BOOKS: -

1. Scilab Group, SCILAB REFERENCE MANUAL, On-line Documentation, INRIA Meta
2. Project / ENPC Cergrene, INRIA.

REFERENCE BOOKS:-

1. Vinu V. Das, (2008), Programming in Scilab, New Age International (P) Limited.
2. Domaine de Voluceau - Rocquencourt – B, (2010), INTRODUCTION TO SCILAB Consortium SCILAB.
3. Gilberto E. Urroz, (2002), Programming with SCILAB.
4. Tejas Sheth, (2016), SCILAB: A Practical Introduction to Programming and Problem Solving.
5. Dr. M. Affouf, Scilab by example, 2012, ISBN: 978-1479203444

Semester – V			
19UMTDC501	**DSE – Core 1: Advanced Topics in Mathematical Analysis**	**3 hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the concept of metric space and its structure.
2. Determine closed-ness of the given set with respect to given metric.
3. Discuss and criticize the properties of Countable sets and Cantor set.
4. Evaluate and determine the compactness of the given sets in a metric space.
5. Analyze and criticize the connectedness of sets in metric space.

Unit 1: Metric space **(7 Hrs)**

- Metric Space – definition and problems based on it
- Usual Metric Space and Discrete Metric Space
- Problems based on Discrete Metric Space
- Some important results based on Discrete Metric Space.
- Neighbourhood , Interior point , Open set
- Problems based on Open set and Neighbourhood
- Hausdorff Principle
- Open sets in metric space
- Neighbourhood as an Open set
- Open interval as an open set

Unit 2: Closed Set **(6 Hrs)**

- Limit point, Closed set , Derived set, Dense set , Nowhere Dense
- Problems based on Closed set, derived set
- Results based on Closed set
- Boundary points of a set and problems based on it
- Results based on closure of a set

Unit 3: Countable set and Cantor set **(7 Hrs)**

- Fundamentals of one-one function and onto function
- Definition of Similar sets
- Problems based on similarity of sets
- Countable sets and problems based on Countable set
- Definition of the Cantor set
- Some important properties of the Cantor set
- Representation of Real number or m- based expression

Unit 4: Compact set **(8 Hrs)**

- Separated set in a metric space
- Difference between disjoint & Separated set
- Definition and examples of Cover of a set
- Definition and examples of Sub cover , Open cover
- Compact sets
- Some important results of Compact set
- Heine Boral Theorem
- Problems based on these concepts

Unit 5: Connected set **(7 Hrs)**

- Connected set
- Some important results based on Connected set
- Boltzano weirstrass theorem
- Nested Interval Theorem
- Totally Bounded sets
- Sequential Compactness
- Results based on Sequential Compactness
- Problems based on these concepts.

TEXT BOOKS: -

1. J. N. Sharma and A. R. Vashishtha, (2017), Mathematical Analysis - I , Krishna PrakashanMandir , MEERUT(U.P.)

REFERENCE BOOKS:-

1. S.C.Malik&SavitaArora, (2009), Mathematical Analysis , New Age Int. Pvt.Ltd .
2. Shantinarayana, 2003), A first course of Mathematical Analysis , S. Chand & sons.
3. Tom.M.Apostol ,(1985), Mathematical Analysis , Narosa Publishing House.
4. R.R.Goldberg, (1970), Methods of Real Analysis , Oxford & IBH Publishing Co. Pvt. Ltd.
5. H. L. Royden, (2015), Real Analysis , Prentice Hall of India Pvt Ltd. New Delhi.

Semester – V			
19UMTDC502	**DSE-Core 1: Topology**	**3 hrs/wk**	**3 Credits**

Objectives:

Upon completion of the course students will be able to

1. Recognize and interpret the topological structures and their characterizations.
2. Identify and understand the subspace topology and product topology.
3. Identify and classify the type of topology including quotient topology and metric topology.
4. Understand and differentiate the hierarchy of the topological spaces and their characterizations.

Unit 1 Topological spaces **(10hrs)**

- Topological spaces
- Basis for a Topology

Unit 2The Subspace Topology **(10hrs)**

- The Subspace Topology
- Order Topology

Unit 3 Continuity **(9hrs)**

- Continuous functions
- Metric Topology

Unit 4$T_1$and T_2 spaces **(10hrs)**

- T_1- spaces
- Hausdorff spaces

Unit 5Regular and Normalspaces **(9hrs)**

- Regular spaces and Normal spaces
- Urysohn's Lemma and Tietze extension theorem

TEXT BOOKS: -

1. Munkres J., Topology: A first course, Prentice-Hall of India Pvt. Ltd, New Delhi.

REFERENCE BOOKS:-

1. Simmons G. F., Introduction to Topology and Modern Analysis, McGraw Hill Company, Tokyo.

2. Willards S., General Topology, Addition-Wesley, Reading, 1970.

Semester – VI			
19UMTCC601	**Core 15 : Ring Theory**	**3hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the basic ideas and notions of abstract algebra.
2. Define and recognize the abstract mathematical structures including Rings and sub-rings.
3. State and criticize the properties of Rings.
4. Define and recognize the Ideals of given Rings.
5. Define and recognize the homomorphism of rings and utilize its properties.

Unit 1: Ringand Integral Domains (12 hrs)

- Definition and examples of Ring
- Properties of Ring
- Further examples of Rings
- Definition and example of Integral Domain
- Zero divisors
- Characteristic of a Ring
- Theorems on Integral Domain

Unit 2: Ideals and Quotient Rings (12 hrs)

- Left and Right Ideals, Proper and improper ideals.
- Definition of Subring
- Definition of Ideals
- Quotient Ring
- Theorems on Ideals and Its Examples

Unit 3: Homomorphism (12 hrs)

- Definition and examples of a Ring homomorphism
- Properties of Ring Homomorphism
- Homomorphism and Characteristic
- Theorems on Ring Homomorphism

Unit 4: Isomorphism (12 hrs)

- Definition and examples of a Isomorphism of rings.
- Properties of Isomorphism of rings.
- First theorem on Isomorphism.
- Theorems on Isomorphism.

Unit 5: Polynomial Ring (12 hrs)

- Definition and Examples of Polynomial Ring
- Reducible and irreducible polynomials, Factorization of polynomials
- G.C.D. of polynomials, Quaternion

TEXT BOOKS: -

1. I.H.Sheth, Abstact Algebra, Prentice/Hall of India Private Limited, new delhi (Unit- 1 to5)
2. I. N. Herstein, 1975, Topics in Algebra, John Wiley & Sons, New York (Unit- 1 to5)
3. Goyal& Gupta, Advanced Course Modern Algebra, Pragati Prakation.

REFERENCE BOOKS:-

1. Thomas W. Judson, Abstract Algebra Theory and Applications, Stephen F. Austin State University, 2009.
2. Marlow Anderson & Todd Fel, A first course in Abstract Algebra (Rings, Groups & fields), Chrpman&Halilereivy
3. Fraleigh J.B., A First Course in Abstract Algebra, Narosa Publishing, New Delhi.
4. Joseph A. Gallian, Contemporary Abstract Algebra, Forth Edition, Narosa Publishing House (Unit- 1 to5)

SEMESTER – VI			
19UMTCC602	**Core 16: Optimization through Mathematical Programming.**	**Theory:2 hrs/week Tutorial:1hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the importance and scope of the subject Operations Research.
2. Develop and formulate problems in mathematics terms from given real life problems.
3. Solve linear programming problems with the methods including Simplex Method.
4. Solve Transportation Problems, Assignment Problems and Sequencing Problems.
5. Understand, analyze and effectively solve the problems related to the theory of games.

Unit 1: Introduction to Operations Research (4Hrs)

- History and development of Operations Research
- Applications and scope of Operations Research
- The linear programming problems
- Formulation of LPP
- Matrix form of the LPP
- General form, Canonical form
- Standard form of the LPP
- Graphical method to solve LPP
- Some definitions and basic properties of convex sets
- Convex functions and concave function.

Unit 2:Linear Programming Problems (9Hrs)

- Basic definitions to use Simplex method
- Simplex method (algorithm) to solve LPP
- Big-M method (Penalty method) to solve LPP
- Two phase method to solve LPP
- Problems of LPP based on these methods

Unit 3:Duality in LPPand Game Theory (5Hrs)

- Principle of duality in LPP
- Primal LPP and method to find its dual LPP
- Simple problems of duality.
- Introduction to Game Theory
- Two person zero-sum game
- Minimax and maximin principles
- Saddle point of a game
- Games without a saddle point
- Solution of games by dominance rule.
- Iterative method to solve a game.

Unit 4: Transportation Problems (9Hrs)

- The Transportation Problems
- Mathematical and matrix form of TP.
- Initial solution of TP by NWCM, LCM and VAM
- Optimum solution of TP by MODI method (u-v method) (except degenerate solution),
- Balanced and unbalanced TP (Simple problem)

Unit 5: Assignment problemsand Sequencing Problems (8 Hrs)

- Mathematical and matrix form of Assignment Problem
- Hungarian method to solve Assignment Problem
- Problems of Assignment and its solution based on this method.
- Introduction to Sequencing Problems
- Terminology Notations and Assumptions
- Processing n-jobs through two machines
- Processing n-jobs through three machines.

TEXT BOOKS: -

1. J. K. Sharma, (2006), Operations Research (theory and Applications), MacMillan Publishing House .
2. Nita H. Shah, Gor, Ravi M. Soni, Hardik Shah, (2010), Operations Research, PHI Learning.

REFERENCE BOOKS:-

1. R. K. Gupta, (2018), Operations Research, Krishna PrakashanMandir, Meeut.

Semester – VI			
19UMTCC603	**Core 17 : Advanced Topics in Numerical Analysis**	**3 hrs/wk**	**4 Credits**

Objectives: -

Upon completion of the course students will be able to

1. Understand the concept of interpolation.
2. Analyze and process data with equal or unequal interval and interpolate the same for given non-tabulated values.
3. Perform numerical differentiation using various formulae including Gregory-Newton's forward difference formula and Sterling's formula.
4. Perform numerical integration using various formulae including Trapezoidal rule, Simpson's 1/3 rule and Simpson's 3/8 rule.
5. Solve ordinary differential equations numerically using method including Taylor's series method, Picard's method, Euler's method, Runge's method and Runge-Kutta methods.

Unit 1: Central difference interpolation formulae. (10 hrs)

- Introduction.
- Gauss's forward interpolation formula.
- Gauss's backward interpolation formula.
- Sterling's formula.
- Bessel's formula.
- Laplace- Everett's interpolation formula.

Unit 2: Interpolation with unequal intervals. (10 hrs)

- Introduction.
- Divided differences.
- Properties of divided difference.
- Relation between divided differences and forward difference.
- Newton's divided difference formula.
- Lagrange's interpolation formula.
- Inverse interpolation.
- Lagrange's inverse interpolation formula.

Unit 3: Numerical Differentiation. (8 hrs)

- Introduction.
- Numerical Differentiation.
- Derivatives using Gregory-Newton's forward difference formula.
- Derivatives using Gregory-Newton's backward difference formula.
- Derivative using Sterling's formula.

Unit 4: Numerical Integration. **(8 hrs)**

- Introduction.
- Numerical Integration.
- General quadrature formula.
- Trapezoidal rule.
- Simpson‘s 1/3 rule.
- Simpson’s 3/8 rule.

Unit 5: Numerical solution of ordinary differential equations. **(8 hrs)**

- Introduction.
- Solution by Taylor’s series method.
- Picard’s method.
- Euler’s method.
- Runge’s method
- Runge-Kutta methods and its higher order.

TEXT BOOKS: -

1. Numerical methodsby Dr. V. N. Vedamurthy& Dr. N. Ch. S. N. Iyengar, (1998), Vikas Publishing house.

REFERENCE BOOKS:-

1. M. K. Jain, S. R. K.Iyengar, R. K. Jain (1996) Numerical method, Problems & Solutions, by, New Age International Pvt. Ltd.
2. J. B.Scarforough,(1966) Numerical Mathematical Analysis, Oxford & IBH Publi. Co. Pvt. Ltd.

SEMESTER – VI			
19UMTCC604	**Core 18: Complex Analysis**	**3hrs/wk**	**3 Credits**

Objectives: -

Upon completion of the course students will be able to

1. Define continuity, differentiability, analyticity of a function using limits.
2. Determine where a function is continuous/discontinuous, differentiable/non-differentiable,
analytic/ not analytic, or entire/ not entire.
3. Determine whether a real valued function is harmonic or not.
4. Understand the properties of analytic function.
5. Evaluate a contour integral with an integrand which have singularities lying inside or outside the simple closed contour.
6. Recognize and apply the Cauchy's integral formula and the generalized Cauchy's integral
formula.
7. Classify zeros and singularities of an analytic functions.
8. Find the Laurent's series of a rational function.
9. Evaluate improper real integrals and definite integral of trigonometric functions by using
residue theorem.

Unit 1: Analytic Functions **(9hrs)**

- Introduction to functions of complex variables
- Limit, continuity and differentiability of complex functions
- Harmonic functions
- Entire functions
- Analytic functions

Unit 2: Complex integration **(10 hrs)**

- C-R conditions in Cartesian form
- C-R conditions in polar form
- Definite integrals
- Contours
- Statement of Cauchy-Goursat theorem and examples
- Cauchy's integral formula

Unit 3: Fundamental theorem of Algebra **(10 hrs)**

- Higher order derivative of analytic function

- Morera's theorem
- Cauchy's inequality
- Liouville's theorem
- Fundamental theorem of algebra
- Maximum modulus theorem

Unit 4: Mapping and Power series (10hrs)

- Elementary functions
- Mapping by elementary functions
- Mobius mapping
- Linear function
- Bilinear mapping
- Discussion on different types of mapping
- Complex sequence
- Complex series and power series
- Expansion of a complex function in Taylor's series and Laurent's series

Unit 5: Residues and Poles (9hrs)

- Introduction to singular points
- Isolated singular points
- Zeros of complex functions
- Poles and residues of complex function
- Cauchy's residue theorem
- Evaluation of improper real integrals by residue theorem
- Evaluation of definite integral of trigonometric functions by residue theorem

TEXT BOOKS: -

1 R. V. Churchill and J. W. Brown (2003), Complex variables and applications, 7th Edition, McGraw-Hill.

REFERENCE BOOKS:-

1 J. M. Howie (2004), Complex Analysis, Springer-Verlag.
2 M. J. Ablowitz and A. S. Fokas (1998), Complex Variables-Introduction and Applications, (Indian edition) Cambridge University Press.

Semester-VI			
19UMTCC605	**Core Practical 12: Practical on Optimization.**	**4 hrs/Wk**	**2 credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the importance and scope of the subject Operations Research.
2. Develop and formulate problems in mathematics terms from given real life problems.
3. Solve linear programming problems with the methods including Simplex Method.
4. Solve Transportation Problems, Assignment Problems and Sequencing Problems.
5. Understand, analyze and effectively solve the problems related to the theory of games.

List of Experiments

1. Solve the given LPP using Graphical method.
2. Solve the given LPP using Simplex method.
3. Solve the given LPP using BIG -M method.
4. Solve the given LPP using TWO-PHASE method.
5. Obtain DUAL of the given Primal LPP;
6. Find the initial solution of given transportation problem using NWCM method.
7. Find the optimum solution of given transportation problem using LCM method.
8. Find the optimum solution of given transportation problem using VAM method.
9. Find the optimum solution of given transportation problem using MODI method.
10. Find the optimum solution of given assignment problem.
11. Find the optimum solution of given two-person zero sum game without saddle point.
12. Find the optimum solution of given two-person zero sum game using iterative method.
13. To find optimum solution of sequencing problem with n-jobs through two machines.
14. To find optimum solution of sequencing problem with n-jobs through three machines.

TEXT BOOKS: -

1. J. K. Sharma, Operations Research (theory and Applications), MacMillan Publishing House
2. R. K. Gupta, Operations Research, Krishna PrakashanMandir, Meeut.

REFERENCE BOOKS:-

1. Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.
2. KantiSwaroop and Manmohan, Operations Research, Sultanchand and Sons.

Semester-VI			
19UMTCC606	**Core Practical 13: Practical on Advanced Topics in Numerical Analysis.**	**4hrs/Wk**	**2credits**

Objectives: -

Upon completion of the course students will be able to

1. Understand the concept of interpolation.
2. Analyze and process data with equal or unequal interval and interpolate the same for given non-tabulated values.
3. Perform numerical differentiation using various formulae including Gregory-Newton's forward difference formula and Sterling's formula.
4. Perform numerical integration using various formulae including Trapezoidal rule, Simpson's 1/3 rule and Simpson's 3/8 rule.
5. Solve ordinary differential equations numerically using method including Taylor's series method, Picard's method, Euler's method, Runge's method and Runge-Kutta methods.

List of Experiments

1. Gauss forward interpolation formula.
2. Gauss backward interpolation formula.
3. Sterling's formula.
4. Bessel's formula.
5. Laplace-Everett's formula.
6. Interpolation with unequal intervals.
7. Numerical differentiation.
8. Numerical integration.
9. Taylor's formula.
10. Picard's formula.
11. Euler's method.
12. Runge's method
13. Runge-Kutta's method
14. Milne's method

TEXT BOOKS: -

1. Numerical methodsby Dr. V. N. Vedamurthy& Dr. N. Ch. S. N. Iyengar, Vikas Publishing house.

REFERENCE BOOKS:-

1. Introduction to Numerical Analysis (2nd Edition) by C. E. Froberg Addision Wesley, 1979.
2. Numerical method, Problems & Solutions, by M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International Pvt. Ltd., 1996.
3. Numerical Mathematical Analysis, by J. B. Scarforough, Oxford & IBH Publication Co. Pvt. Ltd., 1966.

Semester – VI			
19UMTCC607	**Core Practical 14: Introduction to SAGE.**	**4 hrs/week**	**2 Credits**

Objectives:-

1. Install and use SAGE on computer with different operating systems.
2. Understand and utilize the interface of SAGE effectively.
3. Utilize SAGE commands to solve mathematical problems of symbolic nature.
4. Apply techniques of SAGE to solve mathematical problems numerically.
5. Plot 2D and 3D graphs using the SAGE software.
6. Solve problems of mathematics including Calculus, Linear Algebra, Abstract Algebra and Group Theory.

List of Practical

1. Introduction and practice of usage of variables, constants, data types, some inbuilt (library) constants & functions, how to enter a matrix, how to enter a vector, operators, how to get help etc.
2. To learn the usage of SAGE commands including Solve(), binomial(), maximum on intervals(), sum(), binomial(), prod(),...etc
3. To find limit, derivative, maxima-minima, partial derivative, indefinite and definite integral, numerical integral and Taylor series expansion of a given function
4. To draw a line passing through a given points, polygon, circle and using options in plotting of 2D graphs.
5. To draw the graph of given function in 3D including line, sphere, platonic solids and using options in plotting of 3D graphs
6. Practical based on Simplification, Factorization and expansion of symbolic functions.
7. Practical based on Partial Fractions.
8. Find the solution of problems of Linear Algebra by using SAGE Commands.
9. Find the solution of problems of Number Theory by using SAGE Commands.
10. Find the solution of various problems of Group Theory and Graph Theory by using SAGE Commands.

TEXT BOOKS: -

1. David Joyner, William Stein, (2008), Sage Tutorial.

REFERENCE BOOKS:-

1. Craig Finch, (2011), Sage Beginner's Guide, Packt publishing (Open Source Community).

Semester – VI			
19UMTDC601	**DSE-Core 2: Graph Theory**	**3hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Understand the fundamental concepts in graph theory.
2. Understand the types of a graph and incidence relation.
3. Define subgraph, connected and disconnected graphs. Understand walk, paths, circuits and define tree and some properties of tree.
4. Define cut-set, connectivity and separability. Define planner graphs and their dual graphs. 5. State and prove Kuratowski's first and second non-planner graph. Define vertex coloring, chromatic number and matrix representation of graphs.
6. Apply the concepts of graph theory in a variety of fields.
7. Understand and to construct mathematical proofs involving graphs.

Unit 1:Introduction (9hrs)

- Basic definitions and simple examples.
- Directed, Undirected, multi-graph, mixed graph.
- Incidence relation and degree of the graph.
- Complete, regular graphs.
- Sub graph, connected and disconnected graphs.
- Matrix associated with graph-Adjacency matrix, Incidence matrix, Path matrix.

Unit 2: Paths and Circuits (6 hrs)

- Walk and unilateral components.
- Isomorphism
- Koningsberg bridge problem
- Euler graphs, Unicursal graph, Operation of graph, Circuit & Tree.
- Hamiltonian path and cycles.

Unit 3: Trees and Fundamental Circuits (9 hrs)

- Tree.
- Some properties of Trees.
- Distance and Centers of Trees.
- Rooted and Binary Trees.
- Cut-set, connectivity and separability.
- Fundamental Circuit and Cut-Set.

Unit 4: Planar and Dual Graphs (9 hrs)

- Planar graphs and their different representation.
- Dual of a planar graph.

- Euler's formula.
- Kuratowski's first and second non-planar graph.
- Dual graph,Self dual graph

Unit 5: Vector space associated with a graph and Coloring (6 hrs)

- Vector associated with a graph.
- Vector associated with subgraph of a graph.
- Circuit vector and cut sets vector.
- Vertex coloring , edge coloring.
- Chromatic number, Chromatic partition.
- Maximal Independents set, Independence number ,MIS

TEXT BOOKS: -

1. NarsinghDeo (1992), Graph Theory with applications to engineering and computer science, Prentice-Hall of India Pvt. Ltd. New Delhi.(Unit-1 to5)
2. John Clark and Derek Allan Holton (1991), A First Look at Graph Theory – Allied Publishers Limited. (Unit-1 to5)

REFERENCE BOOKS:-

1. R. J. Wilson (1985), Introduction to Graph Theory, Longman. (Unit-1 to5)
2. Douglas B. West, Introduction to Graph Theory, Prentice-Hall of India, Second Edition, 2006, ISBN-81-203-2142-1. (Unit-1 to5)
3. S. Arumugam, S. Ramchandran, (2006), Invitation to Graph Theory, Scitech Publication (India) Pvt. Ltd, Chennai. (Unit-1 to5)
4. S. A. Choudum (2000), A First Course in Graph Theory, Macmillan India Limited. (Unit-1 to5)

Semester – VI			
19UMTDC602	**DSE-Core2: Basics of Number Theory**	**3hrs/week**	**3 Credits**

Objectives:-

Upon completion of the course students will be able to

1. Prove results involving divisibility and greatest common divisors;
2. Solve systems of linear congruences;
3. Find integral solutions to specified linear Diophantine Equations;
4. Apply Euler-Fermat's Theorem to prove relations involving prime numbers;
5. Apply the Wilson's theorem.

Unit 1. Introduction: (7 Hrs)

- Algebraic operations with integers,
- Well Ordering Principle, Pigeon Hole Principle, Principle of Mathematical Induction,
- Divisibility and division algorithm,
- Representation of integers in different bases, The greatest Common Divisor,
- The Euclidean Algorithm (without proof), Lame's theorem.

Unit 2. Prime Numbers: (7 Hrs)

- Prime and composite number,
- Fundamental Theorem of Arithmetic (without proof), canonical form of a number, the Sieve of Eratosthenes, Least Common Multiples,
- Linear Diophantine Equations-The function [x] and the "O" and "o" symbols,
- Theory of Congruence: Definition and basic properties of congruence,
- Residue class & complete system of residues.

Unit 3.Congruences: (7 Hrs)

- Introduction to congruences, Residue system,
- Euler's phi- function, Linear congruences, The Chinese Remainder Theorem,
- Theorems of Fermat, Euler and Wilson, problems on Euler's theorem.

Unit 4. Multiplicative Number theoretic Functions: (7 Hrs)

- Definitions and properties, The Euler phi function,
- The Sum of Divisors function,
- The Number of Divisors functions,
- The Mobius function, the Mobius inversion formula,
- The Perfect, Mersenne, and Fermat Numbers.

Unit 5. Primitive roots: (8 Hrs)

- The order of integers and primitive roots,
- Primitive roots for prime,
- Existence of primitive roots.

TEXT BOOKS: -

1. David M. Burton, (2007), Elementary Number Theory, Sixth Edition, Universal Book stall, New Delhi.

REFERENCE BOOKS:-

1. Niven and Zuckerman, (1991), An introduction to the Theory of numbers, Wiley Eastern Ltd.
2. Gareth A. Jones & J. Mary Jones, (1998), Elementary Number Theory, Springer Verlag.