SEMESTER-I

MAT-C-01: Differential Calculus
Total marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial

Credits: 04 (3+1)

Course Objectives: The main objective of this course is to introduce the important concept of calculus, namely, limits, continuity, differentiability of functions and their various applications, to apply the Rolle's theorem, mean value theorem and Taylor's theorem in various problem.

Course Learning Outcomes: The course will enable the students to:

i) Know about methods to differentiate functions.
ii) Learn about to find tangent, normal, curvature, asymptotes etc., of a given curve.
iii) Understand to address the criteria of changing functions.

CONTENTS

Unit 1: Limit of a function, algebra of limits, related results and problems.

Unit 2: Continuity (s and 8 definition), related theorems and problems, types of discontinuities, differentiability of functions.

Unit 3: Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

Unit 4: Rolle's theorem, mean value theorem, Taylor's theorem with Lagrange's and Cauchy's form of remainder, Taylor's series.

Text Books:

1. Arumugam S., Somasundaram A., & Isaac A.T., Differential Calculus, CBS Publishers, 2021.

2. Thomas G.B. & Finney R.L., Calculus, Pearson Education, 2007.

3. Anton H., Bivens 1. & Davis S., Calculus, John Wiley and Sons Inc., 2002.

Reference Books:

1. Shanti Narayan and P.K. Mittal, Differential Calculus, S. Chand, 2005

SEMESTER-I

MAT-M-01: Differential Calculus
Total marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial

Credits: 04 (3+1)

Course Objectives: The main objective of this course is to introduce the important concept of calculus, namely, limits, continuity, differentiability of functions and their various applications, to apply the Rolle's theorem, mean value theorem and Taylor's theorem in various problem.

Course Learning Outcomes: The course will enable the students to:

i) Know about methods to differentiate functions.
ii) Learn about to find tangent, normal, curvature, asymptotes etc., of a given curve.
iii) Understand to address the criteria of changing functions.

CONTENTS

Unit 1: Limit of a function, algebra of limits, related results and problems.

Unit 2: Continuity (s and 8 definition), related theorems and problems, types of discontinuities, differentiability of functions.

Unit 3: Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

Unit 4: Rolle's theorem, mean value theorem, Taylor's theorem with Lagrange's and Cauchy's form of remainder, Taylor's series.

Text Books:

1. Arumugam S., Somasundaram A., & Isaac A.T., Differential Calculus, CBS Publishers, 2021.

2. Thomas G.B. & Finney R.L., Calculus, Pearson Education, 2007.

3. Anton H., Bivens 1. & Davis S., Calculus, John Wiley and Sons Inc., 2002.

Reference Books:

1. Shanti Narayan and P.K. Mittal, Differential Calculus, S. Chand, 2005

SEMESTER-II

MAT-C-02: Real Analysis
Total marks: 100 (Theory: 80, Internal Assessment: 20)
Per week : 3 Lectures, 1 Tutorial
Credits: 04 (3+1)

Course Objectives: The objectives of this Course are-To explain the deep understanding of real line and of important terins to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

Course Learning Outcomes: This course will enable the students to:

i) Understand many properties of the real line R, including completeness and Archimedean properties.

ii) Learn to define sequences in terms of functions from N to a subset of R.

iii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence. Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Unit 1: Algebric and order properties of R, absolute value and real line, bounded sets, supremum and infimum, completeness property of R, the Archimedean property.

Unit 2: Real sequences, limit of a sequence, convergent sequence, bounded sequence, limit theorems, monotone sequences, monotone convergence theorem, subsequences, monotone subsequence theorem.

Unit 3: Infinite series, convergence and divergence of infinite series, Cauchy criterion, Tests for convergence: comparison test, limit comparison test, ratio test, root test, integral test.

Text Books:

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons, 2002.

2. A Kumar and S. Kumaresan, Basic course in Real Analysis, CRC Press, 2014.

Reference Books:

1. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones & Bartlett, Second Edition, 2010.

2. KA. Ross, Elementary Analysis: The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEMESTER-II

MAT-M-02: Real Analysis
Total marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial,
Credits: 04(3+1)

Course Objectives: The objectives of this Course are -To explain the deep understanding of real line and of important terms to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

Course Learning Outcomes: This course will enable the students to

i) Understand many properties of the real line R, including completeness and Archimedean properties.

ii) Learn to define sequences in terms of functions from N to a subset of R.

iii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence. Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Unit 1: Algebric and order properties of R, absolute value and real line, bounded sets, supremum and infimum, completeness property of R, the Archimedean property.

Unit 2: Real sequences, limit of a sequence, convergent sequence, bounded sequence, limit theorems, monotone sequences, monotone convergence theorem, subsequences, monotone subsequence theorem.

Unit 3: Infinite series, convergence and divergence of infinite series, Cauchy criterion, Tests for convergence: comparison test, limit comparison test, ratio test, root test, integral test.

Text Books:

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons, 2002.

2. A Kumar and S. Kumaresan, Basic course in Real Analysis, CRC Press, 2014.

Reference Books:

1. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones &Bartlett, Second Edition, 2010.

2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEMESTER-III

MAT-C-03: Algebra
Total marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04 (3+1)

Course Objectives: The primary objective of this course is to introduce the basic tools of set theory, functions, induction principle, theory of equations, complex numbers, number theory, matrices and determinant understand their connection with the real-world problems.

Course Learning Out comes: This course will enable the students to:

i) Employ DE Moivre's theorem in a number of applications to solve numerical problems.

ii) Learn about equivalent classes and cardinality of a set.

iii) Use modular arithmetic and basic properties of congruences.

iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. v) Learn about the solution sets of linear systems using matrix method.

UNIT-1: Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indicesand its applications.

UNIT-2: Statements and logic, statements with quantifier, compound statements, implications, proofs inMathematics; Sets, operations on sets, family of sets, power sets, Cartesian product.

UNIT-3: Relation, Equivalence relations, Equivalence classes and partitions of a set, congruence modulo n in integers; Induction Principles.

UNIT-4: Systems of Linear Equations, row reduction and echelon forms, vector equations, the matrix equation Axb, solution sets of linear systems, linear independence.

Text Books:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z., Birkhauser, 2006.

2. A Kumar, S. Kumaresan and B.K.Sarma, A Foundation Course in Mathematics, Narosa, 2018.

3. David C. Lay, Linear Algebra and its Applications(3rdEdition), Pearson Education Asia, Indianprint, 2007,

Reference Books:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (3rd Edition), Pearson Education (Singapore) Pvt. Ltd., Indian Reprint, 2005.

2. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

SEMESTER-III

MAT-C-04 Computer Programming
Total Marks: 100: (Theory: 60, Practical: 20, Internal assessment: 20)
Per week: 3 Lectures, 1 Practical
Credits: 04 (3+1)

Course objectives: The objective of this course is to develop logics which help to advance learning of C language, application of C. Programming of some numerical problems in Windows Operating System.

Learning Outcome: This course will enable the students to understand the computer C programming fundamentals. Write structure programmes using C. Apply problem-solving logic using algorithm, work with data files and arrays effectively.

UNIT 1: Introduction to Computers and Programming Characteristics and components of a computer system Hardware and software concepts Programming languages: machine, assembly, high-level Compiler, interpreter, assembler Algorithm and flowchart — definition and examples Problem-solving methodology

UNIT 2: Elementary data types variables, constants and identifiers, integer, character, floating point and string constants, variable declaration, initialization of variables during declaration, constant data types), Syntax and semantics, reserved words, expression in C(operator precedence and associatively, unary, binary and ternary operators, C arithmetic operators, assignment operators, relational operators, logical and bitwise operators, L-value and R-value, expression statement, cast and size of operator, automatic type conversion.

UNIT 3: Conditional Statement if, if-else, switch Iterative statement: while, do while. For Arrays and pointers (preliminary ideas). Other statements, break, continue, go to, return, null statement, block statement

UNIT 4: Arrays, One dimensional arrays, declaration of one 06 00 dimensional array, initialization of two dimensional arrays, multidimensional array.

UNIT 5: List of Practical:

i) Simple and Compound Interest
ii) Arithmetic Operations
iii) Finding factorial
iv) Some of first and natural numbers
v) Solution of quadratic equations
vi) Checking of Prime numbers
vii) Printing of a matrix
viii) Printing of numbers in various forms, number table
ix) Test for palindrome
x) Finding square root of a number.

Text Books:

i) E. Balaguruswamy - Programming in ANSIC, Tata Mc Grow Hill
ii) Let us C-Y, Kanetkar, BP Publication

Reference Book:

i) Reema Thareja, Programming in C
ii) Yashavant Kanetkar, Let Us C

SEMESTER-III

MAT-M-03: Algebra
Total marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04(3+1)

Course Objectives: The primary objective of this course is to introduce the basic tools of set theory, functions, induction principle, theory of equations, complex numbers, number theory, matrices and determinant understand their connection with the real-world problems.

Course Learning Out comes: This course will enable the students to:

i) Employ DE Moivre's theorem in a number of applications to solve numerical problems.

ii) Learn about equivalent classes and cardinality of a set.

iii) Use modular arithmetic and basic properties of congruences.

iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. v) Learn about the solution sets of linear systems using matrix method.

UNIT-1: Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indicesand its applications.

UNIT-2: Statements and logic, statements with quantifier, compound statements, implications, proofs inMathematics; Sets, operations on sets, family of sets, power sets, Cartesian product.

UNIT-3: Relation, Equivalence relations, Equivalence classes and partitions of a set, congruence modulo n in integers; Induction Principles.

UNIT-4: Systems of Linear Equations, row reduction and echelon forms, vector equations, the matrix equation Axb, solution sets of linear systems, linear independence.

Text Books:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z., Birkhauser, 2006.

2. A Kumar, S. Kumaresan and B.K.Sarma, A Foundation Course in Mathematics, Narosa, 2018.

3. David C. Lay, Linear Algebra and its Applications(3rdEdition), Pearson Education Asia, Indianprint, 2007,

Reference Books:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (3rd Edition), Pearson Education (Singapore) Pvt. Ltd., Indian Reprint, 2005.

2. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

SEMESTER-IV

MAT-C-05: Abstract Algebra
Total Marks: 100 (Theory: 80, Internal assessment: 20)
Per week: 3 lectures, 1 Tutorial
Credits: 04 (3+1)

Course objective: The primary objective of this course is to introduce the basic

concept of rings, subrings, ideals, fields, Integral domains, division rings, characteristic of a ring, ideals, sum of ideals, Product of ideals, homomorphisms of rings and imbeddings: maximal and prime ideals, principal ideal domain, unique factorization domain, polynomial rings, quotient rings, factorization of polynomials, irreducibles, primes.

Course Learning Outcomes: This course will enable the students to:

1. Familiarize with definition and properties of rings, subrings, ideals, fields, Integraldomains, division rings, characteristic of a ring, ideals, sum of ideals, Product of ideals

2. Understand homomorphisms of rings and imbeddings, maximal and prime ideals.

3. Understand principal ideal domain, unique factorization domain, etc. Also polynomialrings, ring of matrices-its ideals and quotients.

UNIT 1: Definitions, examples and properties of rings, subrings, ideals, fields, integral domains, division rings, characteristic of a ring, sum of ideals, product of ideals

UNIT 2: Homomorphisms of rings and imbeddings: maximal and prime ideals, idempotent & nilpotent elements and ideals, nil ideals in a ring, principal ideal, simple ring.

UNIT 3: Principal ideal domain, unique factorization domain and Euclidean domain, quotient rings, field of quotients of an integral domain.

UNIT 4: Factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]. Divisibility in integral domains, irreducibles, prime

Text Books:

1. P. B. Bhattacharya, S. K. Jain, S. R. Nagpaul, Basic Abstract Algebra, Cambbridge University Press, 2nd Edition, 1994.

2. J. A. Gallian, Contemporary Abstract Algebra(4th Edition), Narosa Publishing House, New Delhi, 1999. (IX Edition 2010)

Reference Books:

1. N. Herstein, Topics in Algebra, New Age Publications, 2006.

2. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra, McGraw-Hill, 1997.

3. B.Fraleigh, A first course in Abstract Algebra, 7th Edition, Pearson Education India, 2003.

SEMESTER- IV

MAT-C-06: Complex Analysis (including practical)
Total marks: 100 (Theory: 60, Practical 20, Internal Assessment: 20)
Per week: 3 Lectures, Practical 1
Credits: 04(3+1)

Course objectives: To study the techniques of complex variables and functions together with their derivatives, contour integration and transformations. To study complex power series calculus of residues and it's application.

Course Learning Outcomes: The completion of the course will enable the students to:

i) Learn the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.

ii) Learn some elementary functions and valuate the contour integrals.

iii) Understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.

UNIT 1: Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Limits, Limits involving the point at infinity, continuity.

UNIT 2: Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions.

UNIT 3: Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals.

LAB WORK TO BE PERFORMED ON A COMPUTER (MODELING OF THE FOLLOWING PROBLEMS USING MATLAB/ MATHEMATICA/MAPLE ETC.)

1. Declaring a complex number and graphical representation. c.g. $Z_1 = 3 + 4i$, $Z_2 = 4 - 7i$

2. Program to discuss the algebra of complex numbers, e.g.. $Z_1 = 3 + 4$ and $Z_2 = 4 - 7$, then find
   $Z_1 + Z_2$, $Z_1 - Z_2$, $Z_1 \times Z_2$
3. To find conjugate, modulus and phase angle of an array of complex numbers. .Z=[2 + 3i, 4 - 2i , 6 + 11i, 2 - 5i]

4. To compute the integral over a straight line path between the two specified end points. e. g., Sinz dz, along the contour C which is a straight line path from - 1 + i to 2 - i

5. To perform contour integration., e.g.,

(1) $\oint (z^2 - 2z + 1)\, dz$ along the Contour C given by x = y2 - 1, ; $-2 \leq y \leq 2$

(ii) $\oint (z^3 + 2z^2 + 1)\, dz$ along the contour C given by $x^2 + y^2 = 1$, which can be

6. To plot the complex functions and analyze the graph. e.g.,

(1) f(z) = z, f(z) = e, $f(z) = (z^4 - 1)$ etc.

Text Book:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications (Eighth Edition), McGraw Hill International Edition, 2009.

Reference Books:

1. Joseph Bak and Donald J. Newman, Complex analysis (2nd Edition), Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

2. M.R. Speigel, Complex Variables, Schaum series, Year.

SEMESTER- IV

MAT-C-07: Differential Equations
Total Marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04 (3+1)

Course Objectives: The main objective of this course is to introduce the students to the exciting world of ordinary differential equations, mathematical modeling and their applications.

Course Learning Out comes: The course will enable the students to:

1) Learn basics of differential equations and mathematical modelling.

2) Solve first order non-linear differential equations and linear differential equations of higher order usingvarious techniques.

Unit1: First Order Ordinary Differential Equations

First order exact differential equations, integrating factors, Rules to find an integrating factor.

Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories; Basic theory of higher order linear differential equations, Solving differential equation by reducing its order.

Unit2: Second Order Linear Differential Equations

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation.

Text Books:

1. Kreyszig, Erwin (2011). Advanced Engineering Mathematics(10thed.). John Wiley & Sons, Inc. WileyIndia Edition2015.

2. Ross, Shepley L. (1984). Differential Equations(3rded.). John Wiley & Sons, Inc.

SEMESTER- IV

MAT-C-08: Internship
Total Marks: 100
Credits: 04

Course Objectives of Internship:

i) To provide practical exposure to students in their respective subject area.
ii) To bridge the gap between theory and practice learned in the classroom.
iii) To develop professional skills such as communication, teamwork, and problem-solving.
iv) To gain hands-on experience in laboratories, industries, research centers, schools, or offices.
v) To understand workplace ethics and responsibilities.
vi) To improve technical knowledge and subject-related skills.
vii) To enhance confidence and career readiness.
viii) To develop analytical and critical thinking ability.
ix) To learn time management and organizational skills.
x) To prepare students for higher studies or employment.

Course Learning Outcomes of Internship:

i) After completion of the internship, the student will be able to:
ii) Apply theoretical knowledge gained in the classroom to real-life situations.
iii) Demonstrate practical skills related to their subject area.
iv) Analyze and solve problems in a professional work environment.

SEMESTER-IV

MAT-M-04: Differential Equations
Total Marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04(3+1)

Course Objectives: The main objective of this course is to introduce the students to the exciting world of ordinary differential equations, mathematical modeling and their applications.

Course Learning Out comes: The course will enable the students to:

1) Learn basics of differential equations and mathematical modelling.

2) Solve first order non-linear differential equations and linear differential equations of higher order usingvarious techniques.

Unit1: First Order Ordinary Differential Equations

First order exact differential equations, integrating factors, Rules to find an integrating factor.

Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories; Basic theory of higher order linear differential equations, Solving differential equation by reducing its order.

Unit2: Second Order Linear Differential Equations

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method ofvariation of parameters, The Cauchy-Euler equation.

Text Books:

1. Kreyszig, Erwin (2011). Advanced Engineering Mathematics (10thed.). John Wiley & Sons, Inc. WileyIndia Edition2015.

2. Ross, Shepley L. (1984). Differential Equations(3rded.). John Wiley& Sons, Inc.

SEMESTER-V

MAT-C-09: Metric spaces
Total Marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04(3+1)

Course Objectives: The primary objective of this course is to introduce the basic idea of

Metric space, Complete Metric space, open and closed balls, open set, interior of a set, Limit point of a set, closed set, diameter of a set, Cantor's Theorem, Subspaces, dense sets, separable spaces, Continuous mappings, Uniform continuity, Homeomorphism, Banach Fixed point Theorem, Connectedness, Compactness etc.

Course Learning Outcomes: This course will enable the students to:

1. Understand the properties of Metric space

2. Understand the concept of open and closed balls, neighbourhood, limit point etc.

3. Recognize Continuous mappings, Uniform continuity, Homeomorphism and apply Banach fixed point theorem.

4. Recognize Compactness, boundedness, Connectedness, connected subsets of R.

Unit-1: Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences.

Complete Metric Spaces.

Unit-2: Open and closed balls, neighbourhood, open set, interior of a set, limit point of a set, closed set, diameter of a set, Cantor's theorem, subspaces, dense sets, separable spaces.

Unit-3: Continuous mappings, sequential criterion and other characterizations of continuity, uniformcontinuity, Homeomorphism, contraction mappings, Banach fixed point theorem.

Unit-4: Connectedness: connected subsets of R, connectedness and continuous mappings.

Text Books:

1. S. Shirali & H. L. Vasudeva, Metric Spaces, Springer Verlag London (2006) (First Indian Reprint 2009)

Reference Books:

1. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House, Second Edition 2011.

2. G. F. Simmons, Introduction to Topology and Modern Analysis, Mcgraw-Hill, Edition 2004.

3. S. Lipschutz, Schaum's Outline of General Topology, McGraw Higher ED, 2011

4. J. R. Munkres, Topology, Pearson Education India; 2nd edition, 2015.

MAT-C-10: Linear Algebra
Total Marks: 100: (Theory 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04 (3+1)

Course Objectives: The objective of this course is to introduce the fundamental theory of vector spaces, also emphasizes the application of techniques using the adjoint of a linear operator and their properties to least squares approximation andminimal solutions to systems of linear equations.

Course Learning Outcomes: The course will enable the students to:

i) Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.

ii) Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, and thechange of coordinate matrix.

iii) Compute the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and thealgebraic multiplicities of an eigenvalue and apply the basic diagonalization result.

Unit 1: Vector spaces and subspaces, null space and column space of a matrix, linear transformations, kernel and range, linearly independent sets, bases, coordinate systems.

Unit 2: Eigenvectors and eigenvalues of a matrix, the characteristic equation, diagonalization, eigenvectors of a lineartransformation.

Unit 3: Inner product, length, and orthogonality, orthogonal sets, orthogonal projections, the Gram-Schmidt process, innerproduct spaces; Diagonalization of symmetric matrices, the Spectral Theorem.

Text Books:

1. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Education Asia, Indian Reprint, 2007.

2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

Reference Books:

1. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.

2. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

3. Kenneth Hoffinan, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

4. G. Schay, Introduction to Linear Algebra, Narosa, 1997.

SEMESTER-V

MAT-C-11: Numerical Methods (including practical)
Total marks: 100: (Theory: 60, Practical 20, Internal Assessment: 20)
Per week: 3 Lectures, 1 Practical
Credits: 04 (3+1)

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations. Also, the use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically andanalytically, and to enhance the problem solving skills.

Course Learning Outcomes: The course will enable the students to:

i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.

ii) Know about methods to solve system of linear equations, such as false position method, fixed point iteration method.

iii) Interpolation techniques to compute the values for a tabulated function at points not in the table.

iv) Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

UNIT 1: Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method.

UNIT 2: Lagrange and Newton interpolation: linear and higher order, finite difference operators.

UNIT 3: Numerical differentiation: forward difference, backward difference and central difference.

Integration: trapezoidal rule.

Note: Emphasis is to be laid on the algorithms of the above numerical methods.

Practical/Lab work to be performed on a computer:

Use of computer aided software (CAS), for example Matlab/Mathematica/Maple/Maxima etc., for developing the following Numerical programs:

i) Calculate the sum 1/1+1/2+1/3+1/4 + .+1/N.

ii) To find the absolute value of an integer

) Enter 100 integers into an array and sort them in an ascending order.

iv) Any two of the following

a) Bisection Method

b) Newton Raphson Method

c) Regula Falsi Method) Gauss-Jacobi Method

Note: For any of the CAS Matlab/Mathematica/Maple/Maxima etc., Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Text Books:

1. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, Newage International Publisher, India, 5th edition, 2007.

Reference Book:

1. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th edition, 2008

SEMESTER-V

MAT-C-12: Combinatorics and Graph Theory
Total marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 tutorial
Credits: 04 (3+1)

Course Objectives: This course aims to provide the basic tools of counting principles, pigeonhole principle. Also introduce the basic concepts of graphs, Eulerian and Hamiltonian graphs, and applications to dominoes, Diagram tracing puzzles, Knight's tour problem and Gray codes.

Course Learning Outcomes: This course will enable the students to:

i) Learn about the counting principles, permutations and combinations, Pigeon hole principle

ii) Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and Knight's tour problem.

Unit1: Basic counting principles, Permutations and combinations, the inclusion-exclusion principle, Pigeon hole principle.

Unit2: Graphs, Diagraphs, Networks and sub graphs, Vertex degree, Paths and cycles, Regular and bipartite graphs, Four cube problem, Social networks, Exploring and travelling, Eulerian and Hamiltonian graphs, Applications to dominoes, Diagram tracing puzzles, Knight's tour problem, Gray codes.

Text Books:

1. Aldous, Joan M., & Wilson, Robin J. (2007). Graphs and Applications: An Introductory Approach. Springer. Indian Reprint.

2. Sharad S. Sane, Combinatorial Techniques, Hindustan BookAgency, 2013.

Reference Books:

1. Michael Towusend, Discrete Mathematics; Applied Combinatorics and Graph Theory, Benjamin-Cummings Pub Co (March1, 1987)

2. K.R. Parthasarathi, Basic Graph Theory, Tata McGraw-Hill, 1994.

3. C.L. Liu and D. Mohapatra Elements of discrete mathematics, McGraw Hill, Computer ScienceSeries.2017

SEMESTER-V

MAT-M-05: Metric spaces
Total Marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04(3+1)

Course Objectives: The primary objective of this course is to introduce the basic idea of

Metric space, Complete Metric space, open and closed balls, open set, interior of a set, Limit point of a set, closed set, diameter of a set, Cantor's Theorem, Subspaces, dense sets, separable spaces, Continuous mappings, Uniform continuity, Homeomorphism, Banach Fixed point Theorem, Connectedness, Compactness etc.

Course Learning Outcomes: This course will enable the students to:

1. Understand the properties of Metric space

2. Understand the concept of open and closed balls, neighbourhood, limit point etc.

3. Recognize Continuous mappings, Uniform continuity, Homeomorphism and apply Banach fixed point theorem.

4. Recognize Compactness, boundedness, Connectedness, connected subsets of R.

Unit-1: Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences.

Complete Metric Spaces.

Unit-2: Open and closed balls, neighbourhood, open set, interior of a set, limit point of a set, closed set, diameter of a set, Cantor's theorem, subspaces, dense sets, separable spaces.

Unit-3: Continuous mappings, sequential criterion and other characterizations of continuity, uniformcontinuity, Homeomorphism, contraction mappings, Banach fixed point theorem.

Unit-4: Connectedness: connected subsets of R, connectedness and continuous mappings.

Text Books:

1. S. Shirali & H. L. Vasudeva, Metric Spaces, Springer Verlag London (2006) (First Indian Reprint 2009)

Reference Books:

1. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House, Second Edition 2011.

2. G. F. Simmons, Introduction to Topology and Modern Analysis, Mcgraw-Hill, Edition 2004.

3. S. Lipschutz, Schaum's Outline of General Topology, McGraw Higher ED, 2011

4. J. R. Munkres, Topology, Pearson Education India; 2nd edition, 2015.

SEMESTER-VI

MAT-C-13: Number Theory
Total Marks: 100 (Theory: 80, Internal assessment: 20)
Per week: 3 lectures, 1 Tutorial
Credits: 04(3+1)

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems.

Course Learning Outcomes: This course will enable the students to:

i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.

ii) Know about number theoretic functions and modular arithmetic.

iii) Solve linear, quadratic and system of linear congruence equations.

Unit 1: Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem.

Unit 2: Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi function, Euler's theorem.

Text Books:

1. David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw Hill, Indian reprint, 2007.

2. G. A. Jones and J. Mary Jones, Elementary Number Theory.

Undergraduate Mathematics Series (SUMS). First Indian Print. 2005

Reference Books:

1. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

2. K. C. Chowdhury, A First Course in Number Theory, Asian Books Publications 2012

SEMESTER-VI

MAT-C-14: Partial Differential Equations (including practical)
Total marks: 100: (Theory: 60, Practical 20, Internal Assessment: 20)
Per week: 3 Lectures, 1 Practical
Credits: 04 (3+1)

Course Objectives: The main objectives of this course are to teach students to form and solve partial differential equationsand use them in solving some physical problems.

Course Learning Outcomes: The course will enable the students to:

i) Formulate, classify and transform first order PDEs into canonical form.

ii) Learn about method of characteristics and separation of variables to solve first order PDE's.

iii) Classify and solve second order linear PDEs.

iv) Learn about Cauchy problem for second order PDE and homogeneous and non-homogeneous wave equations.

v) Apply the method of separation of variables for solving many well-known second order PDES.

Unit 1: Introduction, Classification, Construction of first order partial differential equations (PDE). Cauchy's problem for first order equations, linear equations of the first order, Integral surfaces passing through a given curve, Nonlinear partial differential equations of the first order, Cauchy's method of characteristics.

Unit 2: Canonical form of first order PDE, Method of separation of variables for first order PDE.

Practical/Lab work to be performed in a Computer Lab:

Modelling of the following similar problems using Mathematica/MATLAB/Maple/Maxima/Scilab etc.

1. Solution of Cauchy problem for first order PDE.

2. Plotting the characteristics for the first order PDE.

3. Plot the integral surfaces of a given first order PDE with initial data.

4. Solution of wave equation for any two of the following associated conditions: $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$

(a) $u(x, 0) = \varnothing(x)$; $u(x, 0) = \Psi(x)$. $x \in R$; $t > 0$

(b) $u(x, 0) = \varnothing(x)$; $u_t(x, 0) = \Psi(x)$; $u(0, t) = 0$ $x > 0$; $t > 0$

(c) $u(x, 0) = \varnothing(x)$; $u(t)(x, 0) = \Psi(x)$; $u_x(0, t) = 0$, $x > 0$; $t > 0$

(d) $u(x, 0) = \varnothing(x)$; $u_t(x, 0) = \Psi(x)$; $u(0, t) = 0$, $u(l, t) = 0$; $x > 0$; $t > 0$

5. Solving systems of ordinary differential equations.

6. Solution of one-Dimensional heat equation $u_t = ku_{xx}$, for a homogeneous rod of length L. That is-solve the IBVP:

$u_t = k\, u_{xx}$, $0 < x < 1$, $t > 0$
$u(0, t) = 0$ $u(l, t) = 0$ $t >= 0$
$u(0, t) = f(x)$, $0 \leq x \leq l$

Text Book:

1. Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equation for Scientists and Engineers. Springer, Indian reprint, 2006.

2. Sneddon, I. N. (2006). Elements of Partial Differential Equations, Dover Publications. Indian Reprint.

Reference Book:

1. Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). Partial Differential Equations. An Introduction with Mathematica and MAPLE (2nd ed.). World Scientific.

2. M. D. Raisinghania, Advanced Differential Equations, S. Chand & Company LTD.

SEMESTER-VI

MAT-C-15, Analytical Geometry
Total Marks: 100: (Theory: 80, Internal assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04 (3+1)

Course Objectives: The primary objective of this course is to introduce the basic tools of two-dimensional coordinates systems, general conics, and three-dimensional coordinate systems.

Course Learning Outcomes: This course will enable the students to:

Learn conic sections and transform co-ordinate systems

ii) Have a rigorous understanding of the concept of three-dimensional coordinates systems.

UNIT 1: Transformation of coordinates, pair of straight lines. Parabola, parametric coordinates, tangent and normal, ellipse and its conjugate diameters with properties, hyperbola and its asymptotes, general conics: tangent, condition of tangency, pole and polar, center of a conic, equation of pair of tangents, reduction to standard forms, central conics & length of axes.

UNIT 2: Plane, straight lines and shortest distance. Sphere, cone and cylinder, central conicoid, ellipsoid, hyperboloid of one and two sheets, diametral planes, tangent lines, director sphere, polar plane.

Text Books:

1. R. M. Khan, Analytical Geometry of two and three-dimension and vector analysis. New Central Bookagency 2012.

2. R.J.T. Bell, Coordinate Solid Geometry, Macmillan, 1983.

Reference Book:

1. E.H. Askwith, The Analytical Geometry of the Conic Sections, Nabu Press (27 February 2012)

2. B. Das, Analytical Geometry and Vector Analysis, Orient Book Company,

SEMESTER-VI

MAT-C-16: Theory of Real Functions
Total Marks: 100 (Theory: 80, Internal assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04(3+1)

Course Objectives: It is a basic course on the study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concepts of calculus, namely; limits, continuity, differentiability and their applications

Course Learning Outcomes: This course will enable the students to:

i) Have a rigorous understanding of the concept of limit of a function.

ii) Learn about continuity and uniform continuity of functions defined on intervals.

iii) Understand geometrical properties of continuous functions on closed and bounded intervals.

iv) Learn extensively about the concept of differentiability using limits, leading to a better understanding forapplications.

UNIT 1: Cluster point or limit point of a set, limits of a function (e-d approach), sequential criterion for limits, divergence criteria, limit theorems, one sided limits.

UNIT 2: Continuous functions, sequential criterion for continuity and discontinuity, algebra of continuous functions, continuous functions on intervals, maximum-minimum theorem, intermediate value location of roots theorem, preservation of intervals theorem. theorem,

UNIT 3: Differentiability of a function at a point and in an interval, Caratheodory's theorem, chain rule, derivative of inverse function, Rolle's theorem, mean value theorem, Darboux's theorem, Cauchy mean value theorem.

Text Book:

1. R. Bartleand D.R. Sherbert, Introduction to Real Analysis, John WileyandSons, 2015.

Reference Books:

1. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, Indian Edn.2014.

2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer.2004.

3. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.

4. S.R.Ghorpade and B.V.Limaye, A Course in CalculusandReal Analysis, Springer, 2006.

SEMESTER-VI

MAT-M-06 Analytical Geometry
Total Marks: 100: (Theory: 80, Internal assessment: 20)
Per week: 3 Lectures, 1 Tutorial
Credits: 04 (3+1)

Course Objectives: The primary objective of this course is to introduce the basic tools of two-dimensional coordinates systems, general conics, and three-dimensional coordinate systems.

Course Learning Outcomes: This course will enable the students to:

Learn conic sections and transform co-ordinate systems

ii) Have a rigorous understanding of the concept of three-dimensional coordinates systems.

UNIT 1: Transformation of coordinates, pair of straight lines. Parabola, parametric coordinates, tangent and normal, ellipse and its conjugate diameters with properties, hyperbola and its asymptotes, general conics: tangent, condition of tangency, pole and polar, center of a conic, equation of pair of tangents, reduction to standard forms, central conics & length of axes.

UNIT 2: Plane, straight lines and shortest distance. Sphere, cone and cylinder, central conicoid, ellipsoid, hyperboloid of one and two sheets, diametral planes, tangent lines, director sphere, polar plane.

Text Books:

1. R. M. Khan, Analytical Geometry of two and three-dimension and vector analysis. New Central Bookagency 2012.

2. R.J.T. Bell, Coordinate Solid Geometry, Macmillan, 1983.

Reference Book:

1. E.H. Askwith, The Analytical Geometry of the Conic Sections, Nabu Press (27 February 2012)

2. B. Das, Analytical Geometry and Vector Analysis, Orient Book Company,

SEMESTER VII

MAT -C 17: Riemann Integration & Series of Functions

Total Marks: 100 (Theory: 80; Internal assessment: 20)

Credits: 04 (3+1)

Course objectives: The objectives of this course are to-

I) Develop a clear understanding of Riemann integration including the concept of improper integrals.

II) Learn differentiation and integration of power series.

UNIT 1: Concept of Riemann integration, Upper sums and Lower sums, Inequalities of upper and lower sums, Refinement of partitions, Riemann sum and definition of Riemann integral, Equivalent definitions of Riemann integral, Integrability of continuous functions and monotonic functions, Fundamental theorem of calculus, Intermediate value theorem for integrals.

UNIT 2: Improper integral, convergence of Beta and Gamma function gamma functions .

UNIT 3: Point wise convergence and uniform convergence of sequence of functions. Cauchy criterion for uniform convergence Weierstrass M –test, Theorems on continuity and differentiability of the sum of a series of functions.

UNIT 4: Limit superior and Limit inferior, Power series , radius of convergence , Cauchy Hadamard Theorem , Differentiation and integration of power series , Abel's Theorem, Weierstrass Approximation Theorem.

LEARNING OUTCOMES: After the completion of this course the learner will be able to:

I) Understand the families and properties of Riemann integrable functions and the applications of the fundamental theorem of integration.

II) Describe the Beta and Gamma functions and their related properties .

III) Analize the valid conditions for the inter changeability of differentiability and integrability with infinite sum and approximation of transcendental functions of power series.

TEXTBOOKS:

1. Bartle R. and Sherbert D. R., Introduction to Real Analysis, John Wiley and Sons, 2003.
2. Kumar A. & Kumaresan S., A Basic Course in Analysis, CRC Press, 2014.

REFERENCE BOOKS:

1. Ghorpade S. R. and Limaye B. V., A Course in Calculus and Real Analysis, Springer, 2006.
2. Ross K. A., Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
3. Denlinger C. G., Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

SEMESTER VII
MAT–C -18: Linear Programming
Total Marks: 100 (Theory: 80; Internal assessment: 20)

Credits: 04 (3+1)

Course objectives: The objectives of this course are to -

i) Describe various optimization techniques pertaining to linear programming.
ii) Apply linear programming to problems arising out of real life problems.

UNIT 1: Introduction to linear programming problem (LPP), Mathematical formulation of LPP, Basic feasible solution and feasible region, Theory of Simplex Method, Simplex Algorithm, Simplex Method in tabular form, Optimality and Unboundedness , Artificial variables , Two phase method ,Big -M method, Comperison of Two phase and Big M methods, Case study and real life applications.

UNIT 2: Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual.

UNIT 3: Transportation problem and its mathematical formulation, North- West corner method, Least cast method, Vogel's approximation method (VAM), Optimality test and algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem ,Case study and real life problems.

UNIT 4: Game theory: Introduction to game theory, Formulation of two person zero sum games, solving two person zero sum games, game with mixed strategies, Graphical solution method, Linear programming formulation of games, case study and applications.

Learning outcomes:

After the completion of this course the learner will be able to:

1. Understand the basic and formulation of linear programming problem (LPP).

2. Apply various optimization techniques to solve linear programming problems.

3. Analyze and interpret solutions in terms of real life applications.

4. Use graphical and algebraic methods such as simplex method for solving LPPs.

TEXTBOOKS:

1. Sharma J. K., Operations Research: Theory and Applications, 5th Edition, 2012.
2. Taha H. A., Operations Research, An Introduction, 8th Ed., Prentice- Hall India, 2006.

REFERENCE BOOKS:

1. Bazaraa M. S., Jarvis J. J. and Sherali H. D., Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. Hillier F. S. and Lieberman G. J., Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hadley G., Linear Programming, Narosa Publishing House, New Delhi, 2002.

Semester-VII

MAT-C-19: Mechanics and Tensor

Total Marks: 100 (Theory: 80; Internal assessment: 20)

Credits: 04 (3+1)

Course outcome:

After completing the course students will be able to: Differentiate the properties of motion in various coordinate systems viz. cylindrical,spherical,conical surfaces.

i) To apply various tools of vector algebra as well as vector calculus, calculus of variations to discuss the motion of rigid bodies under certain constraints.
ii) To handle various physical laws of motion viz. Carnot's theorem, Kelvin's theorem,Hamiltonian's principle etc with mathematical tools.
iii) To construct mathematical models viz. rigid body to describe motions under certainconstraints or no constraints which are able to analyse the physical scenario.
iv) To understand Tensors. They will be able to derive transformation laws of covariant tensors, contravariant tensors and mixed tensors and to find their ranks.
v) To perform algebraic operations on tensors, to obtain covariant derivatives of various tensors and to express Laplacian in tensor form.
vi) To identify that application of tensors is invaluable to most of the branches of Mathematics, Engineering and Theoretical Physics such Mechanics, Elasticity, Electrodynamics, Relativity etc.

Unit1: Idea of Moment of Inertia, Product of Inertia, D' Alembert's Principle, Motion of a rigid body under finite forces. Motion in three dimensions: Velocity and acceleration in cylindrical and spherical polar coordinates, motion on cylindrical, spherical and conical surfaces.

Unit 2: Motion of a rigid body about a fixed point: Euler's Geometrical and Dynamical systems, Motion under no external forces, Impulsive motions: Carnot's theorem, Kelvin's theorem and Bertrand's theorem.

Unit 3: Generalized coordinates: Lagrange's equation of motion for finite forces in holonomic systems, Case of conservative forces and theory of small oscillation, Hamiltonian Theory: Hamilton's equation of motion, Variational methods, Hamilton's principle, and Principle of least action.

Unit 4: Transformation laws of covariant and contravariant tensors, Mixed tensor, Rank of tensors, Kronecker delta. Algebraic operations on tensors: contraction, inner and outer product of tensors, Quotient law, Group property of tensors, symmetric and anti-symmetric tensors. Related theorems. Riemannian metric and Fundamental tensors. Christoffel symbols of the first and
second kinds and their properties. Transformation laws of Christoffel symbols. Covariant derivatives of tensors A_i ,A^i, A_{ij}, A^{ij} and A^i_j , Generalizations. Covariant derivatives of

fundamental tensors and scalar invariant function, Application in problems. Angle between two vectors and orthogonal condition. Gradient of an invariant function. Divergence and curl of vectors. Laplacian in tensor form.

Learning Outcomes: By the end of this course, students will be able to:

i) Analyze Motion in 3D: Differentiate and calculate motion properties across cylindrical, spherical, and conical coordinate systems.

ii) Apply Mathematical Tools: Use vector algebra, vector calculus, and the calculus of variations to solve rigid body problems.

iii) Implement Physical Laws: Solve complex mechanical problems using Hamiltonian and Lagrangian frameworks and classical theorems (Carnot, Kelvin, etc.).

iv) Master Tensor Calculus:

Understand the transformation laws for covariant, contravariant, and mixed tensors.

Perform algebraic operations and find the rank of tensors.

Calculate covariant derivatives and express the Laplacian operator in tensor form.

Text Books:

1. S L Loney, An Elementary Treatise on the Dynamics of a Particle and Rigid Bodies, CambridgeUniversity Press, 2017
2. Murray Spiegel, Theory & problems of theoretical mechanics (Schaum's outline series),McGrawHill Education, 2017
3. C. E. Weatherburn, An Introduction to Riemannian Geometry and the Tensor Calculus, Cambridge University Press, Paperback, 2008

Reference Books:

1. S. L. Loney, The Elements of Statics & Dynamics, Part-II Dynamics, 2016
2. F. Chorlton, Text Books of Dynamics,John Wiley & Sons, 1983
3. L. P. Eisenhart, Riemannian Geometry, Princeton University Press, 1997
4. B. C. Kalita,Tensor Calculus and Applications: Simplified Tools and Techniques, CRC Press,2019.

Semester-VII

MAT-C-20: Research Methodology

Total Marks: 100

Credits: 04

Course Objectives of Research Methodology:

I. To introduce the basic concepts of research and scientific investigation.
II. To develop understanding of different types of research (theoretical, experimental, survey, etc.).
III. To teach methods of data collection and analysis.
IV. To develop skills in formulating research problems and hypotheses.
V. To understand sampling techniques and research design.
VI. To learn the use of statistical tools in research work.
VII. To develop report writing and documentation skills.
VIII. To create awareness about research ethics and plagiarism.
IX. To improve analytical and critical thinking ability.
X. To prepare students for project work, dissertation, or higher studies.

Course Learning Outcomes:

After completing the course, students will be able to:

I. Understand the basic concepts and objectives of research.
II. Identify and formulate a clear research problem.
III. Design an appropriate research plan (research design and methodology).
IV. Apply suitable data collection methods such as surveys, experiments, or observations.
V. Use basic statistical tools for data analysis and interpretation.
VI. Formulate and test research hypotheses.
VII. Interpret results and draw logical conclusions.
VIII. Prepare a structured research report or project work.
IX. Follow research ethics and avoid plagiarism.
X. Develop analytical, critical thinking, and problem-solving skills

SEMESTER VII

MAT -M- 07: Riemann Integration & Series of Functions
Total Marks: 100 (Theory: 80; Internal assessment: 20)

Credits: 04 (3+1)

Course objectives: The objectives of this course are to-

I) Develop a clear understanding of Riemann integration including the concept of improper integrals.
II) Learn differentiation and integration of power series.

UNIT 1: Concept of Riemann integration, Upper sums and Lower sums, Inequalities of upper and lower sums, Refinement of partitions, Riemann sum and definition of Riemann integral, Equivalent definitions of Riemann integral, Integrability of continuous functions and monotonic functions, Fundamental theorem of calculus, Intermediate value theorem for integrals.

UNIT 2: Improper integral, convergence of Beta and Gamma function gamma functions .

UNIT 3: Point wise convergence and uniform convergence of sequence of functions. Cauchy criterion for uniform convergence Weierstrass M –test, Theorems on continuity and differentiability of the sum of a series of functions.

UNIT 4: Limit superior and Limit inferior, Power series , radius of convergence , Cauchy Hadamard Theorem , Differentiation and integration of power series , Abel's Theorem, Weierstrass Approximation Theorem.

LEARNING OUTCOMES: After the completion of this course the learner will be able to:

I) Understand the families and properties of Riemann integrable functions and the applications of the fundamental theorem of integration.
II) Describe the Beta and Gamma functions and their related properties .
III) Analize the valid conditions for the inter changeability of differentiability and integrability with infinite sum and approximation of transcendental functions of power series.

TEXTBOOKS:

3. Bartle R. and Sherbert D. R., Introduction to Real Analysis, John Wiley and Sons, 2003.
4. Kumar A. & Kumaresan S., A Basic Course in Analysis, CRC Press, 2014.

REFERENCE BOOKS:

4. Ghorpade S. R. and Limaye B. V., A Course in Calculus and Real Analysis, Springer, 2006.
5. Ross K. A., Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
6. Denlinger C. G., Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

Semester-VIII

MAT-C-21: Probability and Statistics

Total Marks: 100 (Theory: 80; Internal assessment: 20)

Credits: 04 (3+1)

Course Objectives:
i) Understand statistical techniques.
ii) Learn various probability distributions and their properties.
iii) Develop the mathematical foundation of probability theory.

Unit I: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Unit II: Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient.

Unit III: Joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables (Matrix approach), Chebyshev's inequality.

Unit IV: Statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance.

Learning Outcomes: After the completion of this course the learner will be able to:

i) Apply probability distributions to study the joint behavior of two random variables.
ii) Develop formulations to predict one variable in terms of another i.e. co-relation and linear regression.
iii) Understand and apply the central limit theorem to explain the behavior of empirical frequencies in large populations.

TEXTBOOKS:

1. Ross S., First Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
2. Mood A. M., Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007.

REFERENCE BOOKS:

1. Hogg R. V., McKean J. W. and Craig A. T., Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Miller I. and Miller M., Freund J. E., Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.

Semester-VII

MAT-C-22: Project/Dissertation

Credits: 12

Course Objectives:

This course is introduced to impart knowledge about the basic concepts of research and to provide a road map for conducting research.

Learning Outcomes:

After completing this course, students are expected to identify, explain and apply basic concepts of research; acquire information, recognize various issues related to research, software/computer-based applications for research.

Unit 1: Research Methodology
Definitions, Purpose of Research, Types of research, Research approaches, Research Method, Stages of the research process, Background reading & information gathering: Literature survey (different sources of literature survey including online databases), Hypothesis: Identification of Research Problem; Ethical issues in research, Data collection, Data recording and reproducibility, Importance of documentation.

Unit 2: Research Ethics and Publication
Presentation of research findings: Elements of research publications; Seminar presentation; Paper writing; Journal impact factor, h-index; review process.

Unit 3: Statistical Methods and Computer Applications in Mathematics
Statistical methods and computer applications play an dissertation. They help in collecting, analyzing, interpreting and presenting data accurately. Computers make complex calculations faster and more reliable.

Research Methodology References:

Pure math topics (analysis, algebra, topology, number theory): Rudin, Axler, Artin, Diestel

- Applied / numerical topics: Burden & Faires, Chapra
- Statistics / Probability research: Wackerly, Ross, Grimmett & Stirzaker
- Computer methods: Numerical Recipes, MATLAB & Python numeric texts

Semester-VIII

MAT-M-08: Probability and Statistics

Total Marks: 100 (Theory: 80; Internal assessment: 20)

Credits: 04 (3+1)

Course Objectives:
i) Understand statistical techniques.
ii) Learn various probability distributions and their properties.
iii) Develop the mathematical foundation of probability theory.

Unit I: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Unit II: Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient.

Unit III: Joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables (Matrix approach), Chebyshev's inequality.

Unit IV: Statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance.

Learning Outcomes: After the completion of this course the learner will be able to:

i) Apply probability distributions to study the joint behavior of two random variables.
ii) Develop formulations to predict one variable in terms of another i.e. co-relation and linear regression.
iii) Understand and apply the central limit theorem to explain the behavior of empirical frequencies in large populations.

TEXTBOOKS:

3. Ross S., First Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Mood A. M., Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007.

REFERENCE BOOKS:

3. Hogg R. V., McKean J. W. and Craig A. T., Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
4. Miller I. and Miller M., Freund J. E., Mathematical Statistics with Applications, 7th

Ed., Pearson Education, Asia, 2006.