Course Contents for Subjects with Code: MATH

This document only contains details of courses having code **MATH**.

Code	Subject Title	Cr. Hrs	Semester
MATH-101	Mathematics A-I [Calculus (I)]	4	I

Year	Discipline
1	Mathematics-I,II, Chemistry-II, Statistics-I,II,III

Preliminaries

- Real numbers and the real line
- Functions and their graphs
- Shifting and scaling graphs
- Solution of equations involving absolute values
- Inequalities
- Complex numbers system. Polar form of complex numbers, De Moivr's theorem
- Circular function, hyperbolic functions, logarithmic

Limit and Continuity

- Limit of a function, left hand and right hand limits, Theorems of limits
- Continuity, Continuous functions

Derivatives and its Applications

- Differentiable functions
- Differentiation of polynomial, rational and transcendental functions
- Mean value theorems and applications
- Higher derivatives, Leibniz's theorem
- L'Hospitals Rule
- Intermediate value theorem, Rolle's theorem
- Taylor's and Maclaurin's theorem with their remainders

Integration and Definite Integrals

- Techniques of evaluating indefinite integrals
- Integration by substitutions, Integration by parts
- Change of variable in indefinite integrals
- Definite integrals, Fundamental theorem of calculus
- Reduction formulas for algebraic and trigonometric integrands
- Improper integrals, Gamma functions

Recommended Books

1. Thomas, *Calculus*, 11th Edition. Addison Wesley Publishing Company, 2005
2. H. Anton, I. Bevens, S. Davis, *Calculus*, 8th Edition, John Wiley & Sons, Inc. 2005
3. Hughes-Hallett, Gleason, McCallum, et al, *Calculus Single and Multivariable*, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, *Calculus*, Schaum's outlines series, 4th Edition,1999
5. C.H. Edward and E.D Penney, *Calculus and Analytics Geometry*, Prentice Hall, Inc. 1988
6. E. W. Swokowski, *Calculus and Analytic Geometry*, PWS Publishers, Boston, Massachosetts, 1983.

Code	Subject Title	Cr. Hrs	Semester
MATH-102	Mathematics B-I [Vectors & Mechanics (I)]	4	I

Year	Discipline
1	Mathematics-I,II

Vector Algebra

- Introduction to vector algebra
- Scalar and vector product
- Scalar triple product and vector triple product
- Applications to geometry

Vector Calculus

- Limit, continuity and differentiability of vector point functions
- Partial derivatives of vector point functions
- Scalar and vector fields
- The gradient, divergence and curl
- Expansion formulas.

Forces

- Fundamental concepts and principles
- Inertial-non-inertial frames, Newton's laws
- Resultant of several concurrent forces
- The parallelogram law of forces
- Resolution of a forces, triangle of forces
- Lamy's theorem, polygon of forces
- Conditions of equilibrium for a particle
- External and internal forces, principle of transmissibility
- Resultant of like and unlike parallel forces
- Moment of forces about a point, Varigon's theorem
- Moment of a couple, equivalent couples, composition of couples
- Reduction of coplanar forces to a force or a couple

Friction

- Dry friction and fluid friction
- Laws of dry friction, coefficients of friction, angle of friction
- Equilibrium of a particle on a rough inclined plane
- Particle on a rough inclined plane acted on by an external force
- Conditions for sliding or titling

Virtual Work

- Principle of virtual work
- Problems involving tensions and thrust

Recommended Books

1. Fowles, G.R, Cassiday, G.L. *Analytical Mechanics*, 7th Edition, Thomson Brook Cole, 2005
2. Jafferson, B. Beasdsworth, T. *Further Mechanics*, Oxford University Press, 2001
3. Joseph F, Shelley. *Vector Mechanics*, Mc-Graw Hill Company, 1990

4. Murray R. Spiegel, *Theoretical Mechanics*, Schaum's Outline Series, Mc Graw Hill Book Company
5. Hwei P. HSU, *Applied Vector Analysis*, San Diego, New York, 1984.
6. Murray R. Spiegel, *Vector Analysis*, Schaum's Outline Series, McGraw Hill Book Company, 1959
7. D.K. Anand and P.F. Cunnif, *Statics and Dynamics*, Allyn and Becon, Inc. 1984

Code	Subject Title	Cr. Hrs	Semester
MATH-103	Mathematics A-II [Plane Curves & Analytic Geometry]	4	II

Year	Discipline
1	Mathematics-I,II, Chemistry-II, Statistics-I,II,III

Plane Analytics Geometry

- Conic section and quadratic equations
- Classifying conic section by eccentricity
- Translation and rotation of axis
- Properties of circle, parabola, ellipse, hyperbola
- Polar coordinates, conic sections in polar coordinates
- Graphing in polar coordinates
- Tangents and normal, pedal equations, parametric representations of curves

Applications of Integration

- Asymptotes.
- Relative extrema, points of inflection and concavity
- Singular, points, tangents at the origin
- Graphing of Cartesian and polar curves
- Area under the curve, area between two curves
- Arc length and intrinsic equations
- Curvature, radius and centre of curvature
- Involute and evolute, envelope

Analytic Geometry of Three Dimensions

- Rectangular coordinates system in a space
- Cylindrical and spherical coordinate system
- Direction ratios and direction cosines of a line
- Equation of straight lines and planes in three dimensions
- Shortest distance between skew lines
- Equation of sphere, cylinder, cone, ellipsoids, paraboloids, hyperboloids
- Quadric and ruled surfaces
- Spherical trigonometry. Direction of Qibla

Recommended Books

1. Thomas, *Calculus*, 11th Edition. Addison Wesley publishing company, 2005
2. H. Anton, I. Bevens, S. Davis, *Calculus*, 8th Edition, John Wiley & Sons, Inc. 2005
3. Hughes-Hallett, Gleason, McCallum, et al, *Calculus Single and Multivariable*, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, *Calculus*, Schaum's outlines series, 4th edition, 1999
5. C.H. Edward and E.D Penney, *Calculus and Analytics Geometry* Prentice Hall, Inc. 1988
6. E. W. Swokowski, *Calculus and Analytic Grometry* PWS Publishers, Boston, Massachosetts, 1983.
7. Dennis G. Zill & Patric D. Shanahan, *Complex Analysis*, Jones & Barlett Publishers, 2003

Code	Subject Title	Cr. Hrs	Semester
MATH-104	Mathematics B-II [Mechanics (II)]	4	II

Year	Discipline
1	Mathematics-I,II

Kinematics

- Rectilinear motion of particles
- Uniform rectilinear motion, uniformly accelerated rectilinear motion
- Curvilinear motion of particle, rectangular components of velocity and acceleration
- Tangential and normal components
- Radial and transverse components
- Projectile motion

Kinetics

- Work, power, kinetic energy, conservative force fields
- Conservation of energy, impulse, torque
- Conservation of linear ad angular momentum
- Non-conservative forces

Simple Harmonic Motion

- The simple harmonic oscillator, amplitude, period, frequency,
- Resonance and energy
- The damped harmonic oscillator, over damped, critically damped and under damped
- Motion, forces vibrations

Central Forces and Planetary Motion

- Central force fields, equations of motion, potential energy, orbits
- Kepler's laws of planetary motion
- Apsides and apsidal angles for nearly circular orbits
- Motion in an inverse square field

Centre of Mass and Gravity

- Discrete and continuous systems, density of rigid and elastic bodies
- Centroid: Discrete and continuous systems, solid region, region bounded by planes
- Semi circular regions, sphere, hemisphere, cylinder and cone

Recommended Books

1. Fowles, G.R, Cassiday, G.L. *Analytical Mechanics*, 7th Edition, Thomson Brook Cole, 2005

2. Jafferson, B. Beasdsworth, T. *Further Mechanics*, Oxford University Press 2001

3. Murray R. Spiegel, *Theoretical Mechanics*, Schaum's Outline Series, Mc Graw Hill Book Company

4. D.K. Anand and P.F. Cunnif, *Statics and Dynamics*, Allyn and Becon, Inc., 1984

5. Ferdinand P.B and E.R. Johnston, *Statics and Dynamics*, Mc-Graw Hill Book Company, Inc. 1977

Code	Subject Title	Cr. Hrs	Semester
MATH-105	Discrete Mathematics	2	II
Year	Discipline		
1	Mathematics-I,II		

Function and Sequences

- Introduction to sets
- Functions
- Inverses of function
- Sequences
- Big-Oh notation

Elementary Logic

- Introduction to elementary logic
- Propositional calculus
- Methods of proof

Induction and Recursion

- Loop invariance
- Mathematical induction
- Recursive definition
- Recurrence relations

Relations

- Introduction of relation
- Equivalence relations and partitions of sets
- Partially ordered sets
- Special orderings
- Properties of general relations

Principles of Counting

- Pigeon rule the sum rule
- Inclusion exclusion principle
- The product rule and binomial methods

Recommended Books

1. K.A Ross & C.R.B. Wright, *Discrete Mathematics*, Prentice Hall, New Jersey, 2003.
2. Kenneth H. Rosen, *Discrete Mathematics and its Application*, Mc-Graw Hill Company, 2003
3. J.P. Trembley & R.Manoher, *Discrete Mathematical Structure with Application to Computer Science*, McGraw Hill, 1975.
4. Noman L-Brigs, *Discrete Mathematics*, Oxford University Press, 2003

Code	Subject Title	Cr. Hrs	Semester
MATH-111	Elementary Mathematics-I (Algebra)	3	I
			II

Year	Discipline
1	Business Administration, Economics, History
	Botany, Zoology, Chemistry-I, Social Work, Political Science, Mass Communication, Education (Elementary), Education (Secondary), Urdu

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

Sequences and Series: Arithmetic progression, geometric progression, harmonic progression. Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices. Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Books:

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, Algebra 2 and Trigonometry, 1978, Houghton & Mifflin,
2. Kaufmann JE, College Algebra, and Trigonometry, 1987, PWS-Kent Company, Boston
3. Swokowski EW, Fundamentals of Algebra and Trigonometry (6^{th} edition), 1986, PWS-Kent Company, Boston

Code	Subject Title	Cr. Hrs	Semester
MATH-112	Business Mathematics	3	I
Year	Discipline		
1	Commerce		

a. Solution of Simultaneous equation. Solution of quadratic equation,
b. Matrices and determinants: Addition, Subtraction and Multiplication of Matrices, Expansion of Determinants, Inverse of a matrix, Use of matrices in the solution of system of linear equations.
c. Logarithms
d. Mathematics of Finance
    a. Simple & compound interest
    b. Annuities
    c. Ordinary
    d. Simple discount
    e. Calculating present value & future value of money
e. Progression & series
    a. Arithmetic
    b. Geometric
h. Permutations & Combination

BOOKS RECOMMENDED (*Latest Editions)*

1. Syed Hassan Mirza, Business Mathematic for Management and Finance.
2. L W Stafford, Business Mathematics.
3. Richard Lacava, Business Statistics.
4. Lavin, Business Statistics, Prentice Hall Inc.
5. Nasir Ali Syed, and G H Gill, Statistics & Business Mathematics, Fair Publication, Lahore.
6. Z A Bohra, Business Statistics and Mathematics.

Code	Subject Title	Cr. Hrs	Semester
MATH-121	Calculus-I	3	I
Year	Discipline		
1	Physics		

Number systems, bounded and unbounded sets, infimum and superimum, intervals, natural numbers, principle of induction, sequences, convergence, series and products, real valued functions, graphical representation of real valued functions.
Limit of a function, properties of limit, continuity and discontinuity, differentiation, derivatives, higher derivatives, properties of differentiable functions, exponential and logarithmic functions, trigonometric and inverse trigonometric functions, hyperbolic and inverse hyperbolic functions, maxima and minima, mean value theorems, intermediate forms, Taylor's theorem, Maclaurin's series, power series.
Plane curves, polar coordinates, tangents and normals, parabola, ellipse, hyperbola, vectors.
Books Recommended:

1. *Calculus and Analytic Geometry* G. B. Thomas and R. L. Finney, Addison-Wesley Publishing Company, 1996.
2. *Calculus*, E. W. Swokowski, M. Olinick, D. Pence, J.A. Cole, PWS Publishing Co. USA, 1994.
3. *Calculus*, J. Stewart, Books/Cole Publishing Co. USA, 1999.

Code	Subject Title	Cr. Hrs	Semester
MATH-122	Applied Mathematics	3	I
Year	Discipline		
1	Physics		

Basic concepts of statistics, concept of probability, axioms of probability, discrete probability, & continuous probability, frequencies and probabilities, binomial, Poisson, and normal distributions, mode, mean, median, regression and correlation, sampling theory, analysis of variance.

Numerical Analysis, solutions of algebraic and transcendental equations, roots of cubic and biquadratic equations, numerical methods, bisection methods, Newton-Raphson, formula, the secant method, method of false position, numerical solution of simultaneous linear algebraic equations, Gauss elimination method, Cramer's rule, Choleski's factorization method, Jacobi iterative method, numerical integration, rectangular rule, Trapezoidal rule, Simpson's rule, Error analysis.

Books Recommended:

Experimental Measurements: Precision, Error and Truth by N. C. Barford, Addison-Wesley Publishing Company, Inc.

Modern Statistics by Richard Goodman, ARC Books, NY.

Mathematical Methods for Physics and Engineering, F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press, 1997.

Mathematical Physics by E. Butkov, Addison-Wesley Publishing Company, 1968.

Mathematical Methods for Physicists by G. Arfken and H. J. Weber, Academic Press, 1995.

Code	Subject Title	Cr. Hrs	Semester
MATH-123	Calculus-II	3	II
Year	Discipline		
1	Physics		

Riemann integrals and their applications, Fundamental theorems of calculus, area under the curve, integration of rational, irrational, trigonometric, exponential and logarithmic functions, improper integrals, beta and gamma integrals.

Real functions of several variables, directional derivatives, partial derivatives, local maxima and minima, gradient, chain rule, stationary points, mean value theorems, total differentials, implicit functions, curve tracing, tangents, one parameter family of curves, envelops of a family of curves.

Volumes of solids of revolution, area of a surface of revolution, moments and center of gravity, multiple integrals and applications, infinite series, tests for its convergence, root and ratio tests, Gauss and integral tests.

Books Recommended:

1. *Calculus and Analytic Geometry* by G. B. Thomas and R. L. Finney, Addison-Wesley Publishing Company, 1996.
2. *Calculus* by E. W. Swokowski, M. Olinick, D. Pence, J.A. Cole, PWS Publishing Co., USA, 1994.
3. *Calculus* by J. Stewart, Books/Cole Publishing Co., USA, 1999.

Code	Subject Title	Cr. Hrs	Semester
MATH-124	Analytical Geometry	3	II
Year	Discipline		
1	Physics		

Analytical geometry of three dimensions, rectangular, spherical polar and cylinderical polar, direction consines, direction components, projections, angle between two lines, perpendicular lines, equations of a plance in various forms, perpendicular line to a plane, parallel planes, perpendicular planes, equations of st. Line in various forms, plane through a line, perpendicularity and paralleism of lines and planes, perpendicular distance of a point from a line or a plane. Sortest distance between two lines.

Surfaces: Defination of a surface (Parametric form), Examples of surfaces, intercepts, traces, summetry, sketching by parallel plane sections, surfaces of revolution, quadric surfaces, spheres, elipsoids, paraboloids, hyperboloids, cylinders, cones.

Books Recommended:

1. *Calculus and Analytic Geometry* by G. B. Thomas and R. L. Finney, Addison-Wesley Publishing Company, 1996.
2. *Calculus by E. W. Swokowski, M. Olinick, D. Pence, J.A. Cole, PWS Publishing Co., USA, 1994.*
3. *Calculus by J. Stewart*, Books/Cole Publishing Co., USA, 1999.

Code	Subject Title	Cr. Hrs	Semester
MATH-131	Calculus (IT)-I	3	I
Year	Discipline		
1	Information Technology		

Objective

This course provides a systematic introduction to the aspects of differential and integral calculus. It provides a sound foundation in calculus for students of Mathematics and Computer Science. Emphasis of the course is on modeling and applications. The following topics will be covered in this course: Number systems, Intervals, Inequalities, Functions, Solving absolute value equations and inequalities, Limits, Continuity, Limits and continuity of trigonometric functions, Slopes and rates of change, the Derivative, Local linear approximation, Differentials, Analysis of functions, Rolle's theorem and Mean value theorem, the indefinite integral, the definite integral, L'Hopital's rule; Integration, First order differential equations and applications, Second order linear homogeneous differential equations, Polar coordinates and Graph sketching, Conic sections in calculus.

Prerequisites

None

Text Book

- Anton, Bivens and Davis, *Calculus*, 7th Edition, John Wiley and Sons, 2002. ISBN**:** 9971-51-431-1

Reference Books

- Thomas and Finney, *Calculus with Analytic Geometry,* Addison Wesley 10th Edition, 2001. ISBN: 0201163209
- Dennis G.Zill & Michael R. Cullen, *Differential equations with boundary value problems* , 3rd Edition,1992. ISBN: 0534418872
- Online Material: www.mathworld.com

Code	Subject Title	Cr. Hrs	Semester
MATH-132	Calculus (IT)-II	3	II
Year	Discipline		
1	Information Technology		

Objective

The objective of this course is to prepare the students for coordinating problems by various viewpoints and to encourage and motivate the students to think abstractly, and explore possibilities in field of computer science, in particular, computer graphics. Class assignment will be given at the end of each lecture, and Software MATLAB/MATHEMATICA/MAPLE will be used to demonstrate the visualization of surfaces. The following topics will be covered in this course: Motivation and applications of the course, Rectangular coordinates in 3-space, spheres, cylindrical surfaces, Vectors, Scalar (dot) products, projections, Vector (cross) products, Parametric Equations of Lines, Planes in 3-space, Quadric surfaces, Spherical and cylindrical coordinates, Introduction to vector-valued functions, Calculus of vector-valued functions, Change of parameter, Arc length, Unit tangent**,** normal, and binormal vectors, Curvature, Functions of two or more variables, Partial derivatives, The Chain rule, Directional derivatives and Gradients, Tangent planes and normal vectors, Maxima and minima of functions of two variables, Lagrange multipliers, Double integral , Parametric surfaces; Surface area, Triple integral, Line integrals, Green's Theorem, Surface integrals; application of surface integrals, Divergence Theorem, Stoke's Theorem.

Prerequisites

MA 101 – Calculus I

Text Book

Anton, Bivens and Davis, *Calculus*, 7th Edition, John Wiley and sons, 2002.ISBN**:** 9971-51-431-1

Reference Books

Thomas and Finney, *Calculus with Analytic Geometry,* Addison Wesley, 9th Ed, 1999. ISBN: 0201163209

Code	Subject Title	Cr. Hrs	Semester
MATH-201	Mathematics A-III [Linear Algebra]	4	III
Year	Discipline		
2	Mathematics-I,II, Chemistry-II, Statistics-I,II,III		

Matrices, Determinants and System of Linear Equations

- Definition of matrix. various types of matrices
- Algebra of matrices
- Determinant of square matrix, cofactors and minors
- Laplace expansion of determinants
- Elementary matrices, adjoint and inverses of matrices
- Rank of a matrix
- Introduction to systems of linear equations
- Cramer's rule, Guassian elimination and Gauss Jordan method
- Solution of homologenous and non homogenous linear equations
- Net work flow problems

Vector Spaces

- Real vector spaces, subspaces
- Linear combination and spanning set.
- Linear independence and linear dependence, basis and dimension, row space, Colum space and Null space

Linear Transformations

- Introduction to linear transformation
- Matrices of linear transformations
- Rank and nullity
- Eigen values and Eigen vectors
- Diagonalization
- Orthogonal diagonalization
- Orthogonal matrices, similar matrices

Recommended Books

1. Howard Anton and Chris Rorres, *Elementary Linear Algebra Applications Version*, John Wiley and Sons Inc. 9th Edition, 2005
2. W. Keith Nicholoson, *Elementary Linear Algebra*, PWS-Kent Publishing Company, Boston, 2004
3. Bernard Kolman, David R. Hill, *Introduction Linear Algebra with Applications*, Prentice Hall International, Inc. 7th Edition, 2001
4. Stephen H. Friedberg Et al, *Linear Algebra*, Prentice Hall, Inc. 3rd Edition, 2000
5. Seymour Lipschutz, *Theory and Problems of Beginning Linear Algebra*, Schaum's Outline Series, Mc-Graw Hill Company, New York, 1997

Code	Subject Title	Cr. Hrs	Semester
MATH-202	Mathematics B-III [Calculus (II)]	4	III
Year	Discipline		
2	Mathematics-I,II		

Sequence and Series

- Sequences, Infinite series, Convergence of sequence and series
- The integral test, Comparison tests, Ratio test, Root test
- Alternative series, Absolute and conditional convergence
- Power series, Interval and radius of convergence

Functions of Several Variables

- Functions of two variables, Graphs of functions of two variables
- Contour diagrams, Linear functions, Functions of three variables
- Limit and continuity of a function of two variables
- The partial derivative, Computing partial derivatives algebraically
- The second-order partial derivative, Local linearity and the differential
- Tangent planes and normal lines
- Optimization, Maxima and minima of a function of two variables
- Lagrange multipliers
- Various methods for finding area and volume surface of revolution

Multiple Integrals

- Double integral in rectangular and polar form
- Triple integral in rectangular, Cylindrical and spherical coordinates
- Substitutions in multiple integrals
- Moments and centre of mass

Recommended Books

1. Thomas, *Calculus*, 11th Edition. Addison Wesley Publishing Company, 2005
2. H.Anton, I. Bevens, S. Davis, *Calculus*, 8th Edition, John Wiley & Sons, In.2005
3. Hughes-Hallet, Gleason, McCalum, et al, *Calculus Single and Multivarible*, 3rd Edition John Wiley & Sons, Inc 2002
4. Frank A. Jr, Elliott Mendelson, *Calculus*, Schaum's Outline Series, 4th Edition 1999
5. C.H. Edward and E.D Penney, *Calculus and Analytical Geometry* Prentice Hall, Inc. 1988
6. E.W.Swokoski, *Calculus and Analytical Geometry* PWS Publishers, Boston, 1983

Code	Subject Title	Cr. Hrs	Semester
MATH-203	Mathematics A-IV [Ordinary Differential Equations]	4	IV

Year	Discipline
2	Mathematics-I,II, Chemistry-II, Statistics-I,II,III

Introduction to Differential Equations

- Historical background and motivation
- Basic mathematical models: Directional fields
- Classification of differential equations

First Order Differential Equations

- Separable equations
- Modeling with first order equations
- Differences between linear and nonlinear equations
- Exact equations and integrating factors

Second Order Differential Equations

- Homogenous equations
- Homogenous equations with constant coefficients
- Fundamental solutions of linear homogenous equations
- Linear independence and the wronskian
- Method of undetermined coefficients, Variation of parameters

Higher Order Linear Equations

- General theory of *n*th order linear equations
- Homogenous equations with constant coefficients
- The methods of undermined coefficients
- The method of variation of parameters

Series Solution of Second Order Linear Equations and Special Functions

- Series solution near an ordinary point, Legendr's equation
- Regular singular points, Series solution near a regular singular point

Recommended Books

3. W.E. Boyce and Diprima, *Elementary Differential Equations*, 8th Edition, John Wiley & Sons, 2005
4. Erwin, Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 2004
5. Ross, S.L, *Differential Equations*, John Wiley & Sons, 2004
6. Dennis G.Zill & Michael R. Cullen, *Differential Equation With Boundary Value Problems*, PWS Publihing Company, 2000
7. Richard Bronson, *Differential Equations*, 2nd Edition, Schaum's Outline Series, Mc-Graw Hill Company, New York, 1994

Code	Subject Title	Cr. Hrs	Semester
MATH-204	Mathematics B-IV [Metric Spaces & Group Theory]	4	IV

Year	Discipline
2	Mathematics-I,II

Metric Spaces

- Definition and various examples of metric spaces
- Holder's inequality, Cauchy-schwarz and minkowski's inequality
- Open and closed balls
- Neighborhoods
- Open and closed sets
- Interior, Exterior and boundary points
- Limit points, Closure of a set
- Convergence in metric spaces, Cauchy sequences
- Continuity in metric spaces
- Inner product and norm
- Orthonormal sets and basis
- The Gram-Schmidt process

Group Theory

- Binary operations
- Definition, Examples and formation of groups
- Subgroups
- Order of group, Order of an element
- Abelian groups
- Cyclic groups, Cosets, Lagrange's theorem
- Permutation, Even and odd permutations
- Symmetric groups
- Introduction to rings and fields

Recommended Books

1. Micheal, O. Searcoid, *Metric Spaces*, Springer, 2007
2. E. Kreyszig, *Introduction to Functional Analysis with Applications*, John Wiley and Sons, 1978
3. W.A. Sutherland, *Introduction to Metric and Topological Spaces,* Clarendon Press Oxford, 1975
4. E.T. Copson, *Metric Spaces*, Cambridge University, Press, 1968
5. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Company, 1963
6. I.N. Herstein, *Topics in Algebra,* Xerox Publishing Company, 1964.
7. Vivek Sahai and Vikas Bist, *Algebra*, Narosa Publishing House, 1999
8. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, *Basic Abstract Algebra*, C.U.P., 1986

Code	Subject Title	Cr. Hrs	Semester
MATH-205	Graph Theory	2	III
Year	Discipline		
2	Mathematics-I,II		

Course Outline

- Definition and examples of a graph
- Sub graph
- Types of graphs
- Paths, cycles, wheels and walks
- Connected and disconnected graph
- Isomorphism
- Handshaking lemma
- Matrix representation of a graph
- Three puzzles
- Connectivity
- Eulerian graphs
- Hamiltonian graphs
- Shortest path algorithms
- Trees

Recommended Books

1. Robin J. Wilson, *Graph Theory*, 4th Edition, Longman 2000
2. Douglas B. West, *Graph Theory*, 2nd Edition, Prentice Hall 2003
3. V.K.Balakrishnan, *Graph Theory*, Schaum's Ouline 1997
4. Parthasarathy, K.R. *Basic Graph Theory*, McGraw Hill, 1994
5. Bela Bollobas, *Graph Theory*, Springer Verlag, New York, 1979

Code	Subject Title	Cr. Hrs	Semester
MATH-206	Elementary Number Theory	2	IV
Year	Discipline		
2	Mathematics-I,II		

Prime Numbers

- The sieve of eratostheness
- Perfect numbers, Mersenne primes, Fermat numbers
- Theorems related to prime numbers

Divisibility

- Divisibility of primes
- Divisbility of primes
- The Euclidean algorithm, The equation $\acute{a}x + by = c$

Congruences

- Divisbility tests
- Linear congruences, Techniques for solving $\acute{a}x = b(\text{mod } m)$
- The Chinese remainder theorem
- Finding the day of the week

Recommended Books

1. Adler, Andrew, Coury, John E. *The Theory of Numbers*, Jones and Barttlet Publishers, Boston, 1995.
2. Kenneth, H. Rosen, *Elementary Number Theory and Its Applications* Pearson Addison Wesley Publishers, Boston, 2005
3. Tom M, Apostol, *Introduction to Analytic Number*, Springer, New York, 1980.
4. Burton, D.M. *Elementary Number Theory* McGraw Hill, 2000.

Code	Subject Title	Cr. Hrs	Semester
MATH-211	Elementary Mathematics-II (Calculus)	3	III
Year	Discipline		
2	Botany, Zoology, Chemistry-I, Political Science		

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities. Limits and Continuity: Limit of a function, left-hand and right-hand limits, continuity, continuous functions.
Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.
Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

Recommended Books:

1. Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8th edition), 2005, John Wiley, New York
2. Stewart J, *Calculus* (3rd edition), 1995, Brooks/Cole (suggested text)
3. Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston
4. Thomas GB, Finney AR, *Calculus* (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

Code	Subject Title	Cr. Hrs	Semester
MATH-221	Differential Equations-I	3	III
Year	Discipline		
2	Physics		

Classification of differential equations, solution of differential equations, initial and boundary value problems, first order ordinary differential equation, method of solution, separable equations, homogeneous and exact equations, non-exact differential equations.
Second and higher order differential equations, Initial and boundary value problems, linear independence of solutions and Wronskian, method of solution, solutions in series.

Books Recommended:

1. *Advanced Engineering Mathematics* by E. Kreyszig, Wiley, New York, 1999.
2. *Mathematical Methods for Physicists* by G. B. Arfken and H. J. Weber, A Press, New York, 1995.
3. *Mathematical Methods for Physics and Engineering* by K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press, 1997.
4. *A First Course in Differential Equations with Applications* by G. D. Zill Windsor and Schmidt, Prinder R. E. Williamson 1997.
5. *An Introduction to Differential Equations and Dynamical Systems*, McGraw-Hill, 1982.
6. *An Introduction to Differential Equations and their Applications* by S. J. Farlow, McGraw-Hill, 1994.

Code	Subject Title	Cr. Hrs	Semester
MATH-222	Pure Mathematics	3	III
Year	Discipline		
2	Physics		

Sets, relations between sets and operations on sets, Venn diagrams, mappings and their composition, inverse mappings, mathematical logics, statements, conditional statement, axioms, definitions, and theorems, rules of inference and mathematical proof, methods of proof, sequences, the limit of a sequence.
Definition and examples of topological spaces, discrete and indiscrete topologies, coarser and finer topologies, open and close sets, neighborhood, bases and sub bases, limit point, continuity and homeomorphism, metrics and metrics spaces.

Books Recommended:

1. *Principal of Modern Algebra* by J.E. Whitesitt, Addison-Wesley, 1964.
2. *Introduction to topology* by M. Mansfield, Prentice Hall, 1964.

Code	Subject Title	Cr. Hrs	Semester
MATH-223	Differential Equations-II	3	IV
Year	Discipline		
2	Physics		

Laplace transforms method for solving differential equations, convolution theorem, system of equatins, initial value problems, Nonlinear equations, singular solution, Clairaut equation, Bernaulli equation, Riccati equation etc. Power series solution, convergence of power series, ordinary and singular points, solutions near singular points.

Books Recommended:

1. *Advanced Engineering Mathematics* by E. Kreyszig, Wiley, New York, 1999.
2. *Mathematical Methods for Physicists* by G. B. Arfken and H. J. Weber, A Press, New York, 1995.
3. *Mathematical Methods for Physics and Engineering* by K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press, 1997.
4. *A First Course in Differential Equations with Applications* by G. D. Zill Windsor and Schmidt, Prinder R. E. Williamson 1997.
5. *An Introduction to Differential Equations and Dynamical Systems*, McGraw-Hill, 1982.
6. *An Introduction to Differential Equations and their Applications* by S. J. Farlow, McGraw-Hill, 1994..

Code	Subject Title	Cr. Hrs	Semester
MATH-224	Linear Algebra	3	IV
Year	Discipline		
2	Physics		

Vector space, linear dependence, dimensionality, inner product, Hilbert space, linear operators, Gram-Schmidt method, matrices, addition, multiplication, division, derivatives and integrals of matrices, partition of matrices, elementary row operations, systems of linear equations, transpose, unitary and hermitian matrices, eigenvalues and eigen vectors, diagonalization, singular matrix, trace of a matrix, determinants, Cramer's rule, inverse matrix, linear transformation.
Groups, subgroups, homomorphism and isomorphism, group representation, reducible and irreducible representations, Schurs lemma.

Books Recommended:

1. *Advanced Engineering Mathematics* by E. Kreyszig, Wiley, New York, 1999.
2. *Mathematical Methods for Physicists* by G. B. Arfken and H. J. Weber, A Press, New York, 1995.
3. *Mathematical Methods for Physics and Engineering* by K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press, 1997.

Code	Subject Title	Cr. Hrs	Semester
MATH-231	Discrete Mathematics (IT)	3	III

Year	Discipline
2	Information Technology

Objectives

This course introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. It aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. The following topics will be covered in the course: Introduction to logic and proofs, Direct proofs, proof by contradiction, Sets, Combinatorics, Sequences, Formal logic, Prepositional and predicate calculus, Methods of Proof, Mathematical Induction and Recursion, loop invariants, Relations and functions, Pigeon whole principle, Trees and Graphs, Elementary number theory, Optimization and matching, Fundamental structures, Functions (surjections, injections, inverses, composition), relations (reflexivity, symmetry, transitivity, equivalence relations), sets (Venn diagrams, complements, Cartesian products, power sets), pigeonhole principle; cardinality and countability.

Prerequisites

None

Text Book

Rosen, *Discrete Mathematics and Its Applications,* 5th edition, McGraw-Hill, ISBN: 0072424346

Reference Material

- Richard Johnsonbaugh, *Discrete Mathematics,* Prentice Hall, ISBN: 0135182425
- Kolman, Busby & Ross, *Discrete Mathematical Structures*, 4th Edition, 2000, Prentice-Hall, ISBN: 0130831433

Code	Subject Title	Cr. Hrs	Semester
MATH-301	Real Analysis –I	3	V
Year	Discipline		
3	Mathematics-I,II		

Real Number System

- Ordered sets, fields, the field of real numbers
- Completeness property of R
- The extended real number system
- Euclidean spaces
- Finite, countable and uncountable sets

Sequences and Series

- Sequences, subsequences, convergent sequences, Cauchy sequences
- Monotone and bounded sequences, Bolzano Weierstrass theorem
- Series, series of non-negative terms
- Partial sums, the root and ratio tests, integral test, comparison test
- Absolute and conditional convergence

Limit and Continuity

- The limit of a function
- Continuous functions
- Types of discontinuity
- Uniform continuity
- Monotone functions

Differentiation

- The derivative of a function
- Mean value theorems, the continuity of derivatives
- Taylor's theorem

Functions of Several Variables

- Partial derivatives and differentiability, derivatives and differentials of composite functions
- Change in the order of partial derivative, implicit functions, inverse functions, Jacobians
- Maxima and minima

Recommended Books

1. W. Rudin, *Principles of Mathematical Analysis*, 3rd edition, (McGraw Hill, 1976)
2. R. G. Bartle, *Introduction to Real Analysis*, 3rd edition, (John Wiley and Sons, 2000)
3. T. M. Apostol, *Mathematical Analysis*, (Addison-Wesley Publishing Company, 1974)
4. A. J. Kosmala, *Introductory Mathematical Analysis*, (WCB Company , 1995)
5. W. R. Parzynski and P. W. Zipse, *Introduction to Mathematical Analysis*, (McGraw Hill Company, 1982)
6. H. S. Gaskill and P. P. Narayanaswami, *Elements of Real Analysis*, (Printice Hall, 1988)

Code	Subject Title	Cr. Hrs	Semester
MATH-302	Group Theory-I	3	V
Year	Discipline		
3	Mathematics-I,II		

Groups

- Definition and examples of groups
- Abelian group
- Subgroups lattice, Lagrange's theorem
- Relation between groups
- Cyclic groups
- Groups and symmetries, Cayley's theorem

Complexes in Groups

- Complexes and coset decomposition of groups
- Centre of a group
- Normalizer in a group
- Centralizer in a group
- Conjugacy classes and congruence relation in a group
- Double cosets

Normal Subgroups

- Normal subgroups
- Proper and improper normal subgroups
- Factor groups
- Fundamental theorem of homomorphism
- Automorphism group of a group
- Commutator subgroups of a group

Sylow Theorems

- Cauchy's theorem for Abelian and non-Abelian group
- Sylow theorems

Recommended Books

1. J. Rose, *A Course on Group Theory*, (Cambridge University Press, 1978)
2. I. N. Herstein, *Topics in Algebra*, (Xerox Publishing Company, 1964)
3. P. M. Cohn, *Algebra*, (John Wiley and Sons, London, 1974)
4. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, *Basic Abstract Algebra*, (Cambridge University Press, 1986)
5. J. B. Fraleigh, *A First Course in Abstract Algebra*, (Addison-Wesley Publishing Company, 2002)

Code	Subject Title	Cr. Hrs	Semester
MATH-303	Complex Analysis-I	3	V
Year	Discipline		
3	Mathematics-I,II		

The Concept of Analytic Functions

- Complex numbers, complex planes, complex functions
- Analytic functions
- Entire functions
- Harmonic functions
- Elementary functions: complex exponential, logarithmic and hyperbolic functions

Infinite Series

- Power series, derived series, radius of convergence
- Taylor series and Laurent series

Conformal Representation

- Transformation, conformal transformation
- Linear transformation
- Möbius transformations

Complex Integration

- Complex integrals
- Cauchy-Goursat theorem
- Cauchy's integral formula and their consequences
- Liouville's theorem
- Morera's theorem
- Derivative of an analytic function

Recommended Books

1. D. G. Zill and P. D. Shanahan, *Complex Analysis*, (Jones and Bartlett Publishers, 2003)
2. H. S. Kasana, *Complex Variables: Theory and Applications*, (Prentice Hall, 2005)
3. J. W. Brown and R. V. Churchill, *Complex Variables and Applications,* 7th edition, (McGraw Hill Company, 2004)
4. M. R. Spiegel, *Complex Variables*, (McGraw Hill Book Company, 1974)
5. Louis L. Pennisi, *Elements of Complex Variables*, (Holt, Linehart and Winston, 1976)

Code	Subject Title	Cr. Hrs	Semester
MATH-304	Vector and Tensor Analysis	3	V
Year	Discipline		
3	Mathematics-I,II		

Vector Integration

- Line integrals
- Surface area and surface integrals
- Volume integrals

Integral Theorems

- Green's theorem
- Gauss divergence theorem
- Stoke's theorem

Curvilinear Coordinates

- Orthogonal coordinates
- Unit vectors in curvilinear systems
- Arc length and volume elements
- The gradient, divergence and curl
- Special orthogonal coordinate systems

Tensor Analysis

- Coordinate transformations
- Einstein summation convention
- Tensors of different ranks
- Contravariant, covariant and mixed tensors
- Symmetric and skew symmetric tensors
- Addition, subtraction, inner and outer products of tensors
- Contraction theorem, quotient law
- The line element and metric tensor
- Christoffel symbols

Recommended Books

1. F. Chorlton, *Vector and Tensor Methods*, (Ellis Horwood Publisher, Chichester, U.K., 1977)
2. M. R. Spiegel, *Vector Analysis*, (McGraw Hill Book Company, Singapore, 1981)
3. A. W. Joshi, *Matrices and Tensors in Physics*, (Wiley Eastern Limited, 1991)
4. Hwei P. Hsu, *Applied Vector Analysis*, (Harcourt Brace Jovanovich Publishers, San Diego, New York, 1984)

Code	Subject Title	Cr. Hrs	Semester
MATH-305	Topology	3	V

Year	Discipline
3	Mathematics-I,II

Topology

- Definition and examples
- Open and closed sets
- Subspaces
- Neighborhoods
- Limit points, closure of a set
- Interior, exterior and boundary of a set

Bases and Sub-bases

- Base and sub bases
- Neighborhood bases
- First and second axioms of countablility
- Separable spaces, Lindelöf spaces
- Continuous functions and homeomorphism
- Weak topologies, finite product spaces

Separation Axioms

- Separation axioms
- Regular spaces
- Completely regular spaces
- Normal spaces

Compact Spaces

- Compact topological spaces
- Countably compact spaces
- Sequentially compact spaces

Connectedness

- Connected spaces, disconnected spaces
- Totally disconnected spaces
- Components of topological spaces

Recommended Books

1. J. Dugundji, *Topology*, (Allyn and Bacon Inc., Boston 1966)
2. G. F. Simmon, *Introduction to Topology and Modern Analysis*, (McGraw Hill Book Company, New York, 1963)
3. Stephen Willard, *General Topology*, (Addison-Wesley Publishing Co., London, 1970)
4. Seymour Lipschutz, *General Topology*, (Schaum's Outline Series, McGraw Hill Book Company 2004)
5. James R. Munkres, *Topology*, 2nd edition, (Prentice Hall Inc., 2003)

Code	Subject Title	Cr. Hrs	Semester
MATH-306	Differential Geometry	3	V
Year	Discipline		
3	Mathematics-I,II		

Theory of Space Curves

- Introduction, index notation and summation convention
- Space curves, arc length, tangent, normal and binormal
- Osculating, normal and rectifying planes
- Curvature and torsion
- The Frenet-Serret theorem
- Natural equation of a curve
- Involutes and evolutes, helices
- Fundamental existence theorem of space curves

Theory of Surfaces

- Coordinate transformation
- Tangent plane and surface normal
- The first fundamental form and the metric tensor
- Christoffel symbols of first and second kinds
- The second fundamental form
- Principal, Gaussian, mean, geodesic and normal curvatures
- Gauss and Weingarten equations
- Gauss and Codazzi equations

Recommended Books

1. R. S. Millman and G.D. Parker, *Elements of Differential Geometry* (Prentice-Hall, New Jersey, 1977).
2. A. Goetz, *Introduction to Differential Geometry* (Addison-Wesley, 1970).
3. E. Kreyzig, *Differential Geometry* (Dover, 1991).
4. M. M. Lipschutz, *Schaum's Outline of Differential Geometry* (McGraw Hill, 1969).
5. D. Somasundaram, *Differential Geometry* (Narosa Publishing House, New Delhi, 2005).

Code	Subject Title	Cr. Hrs	Semester
MATH-307	Real Analysis –II	3	VI
Year	Discipline		
3	Mathematics-I,II		

The Riemann-Stieltjes Integrals

- Definition and existence of integrals
- Properties of integrals
- Fundamental theorem of calculus and its applications
- Change of variable theorem
- Integration by parts

Functions of Bounded Variation

- Definition and examples
- Properties of functions of bounded variation

Improper Integrals

- Types of improper integrals
- Tests for convergence of improper integrals
- Beta and gamma functions
- Absolute and conditional convergence of improper integrals

Sequences and Series of Functions

- Power series
- Definition of point-wise and uniform convergence
- Uniform convergence and continuity
- Uniform convergence and integration
- Uniform convergence and differentiation
- Examples of uniform convergence

Recommended Books

1. W. Rudin, *Principles of Mathematical Analysis*, 3rd edition, (McGraw Hill 1976)
2. R. G. Bartle, *Intoduction to Real analysis*, 3rd edition, (John Wiley and sons, 2000)
3. T. M. Apostol, *Mathematical Analysis*, (Addison-Wesley Publishing Co., 1974)
4. A. J. Kosmala, *Introductory Mathematical Analysis*, (WCB company, 1995)
5. W. R. Parzynski and P. W. Zipse, *Introduction to Mathematical Analysis*, (Mc Graw Hill company, 1982)
6. H. S. Gaskill and P. P. Narayanaswami, *Elements of Real Analysis*, (Printice Hall, 1988)

Code	Subject Title	Cr. Hrs	Semester
MATH-308	Rings and Vector Spaces	3	VI
Year	Discipline		
3	Mathematics-I,II		

Ring Theory

- Definition and example of rings
- Special classes of rings
- Fields
- Ideals and quotient rings
- Ring homomorphisms
- Prime and maximal ideals
- Field of quotients

Vector Spaces

- Vector spaces, subspaces
- Linear combinations, linearly independent vectors
- Spanning set
- Bases and dimension of a vector space
- Homomorphism of vector spaces
- Quotient spaces

Linear Mappings

- Mappings, linear mappings
- Rank and nullity
- Linear mappings and system of linear equations
- Algebra of linear operators
- Space L(X, Y) of all linear transformations

Matrices and Linear Operators

- Matrix representation of a linear operator
- Change of basis
- Similar matrices
- Matrix and linear transformations
- Orthogonal matrices and orthogonal transformations
- Orthonormal basis and Gram Schmidt process

Eigen Values and Eigen Vectors

- Polynomials of matrices and linear operators
- Characteristic polynomial
- Diagonalization of matrices

Dual Spaces

- Linear functionals
- Dual space
- Dual basis
- Annihilators

Recommended Books

1. J. Rose, *A Course on Group Theory*, (Cambridge University Press, 1978)

2. I. N. Herstein, *Topics in Algebra*, (Xerox Publishing Company, 1964)
3. G. Birkhoff and S. Maclane, *A Survey of Modern Algebra*, (Macmillan, New York, 1964)
4. P. B. Battacharya, S. K. Jain and S. R. Nagpaul, *Basic Abstract Algebra*, (Cambridge University Press, 1986)
5. V. Sahai and V. Bist, *Algebra*, 2nd edition, (Narosa Publishing House, 2003)
6. W. Keith Nicholson, *Elementary Linear Algebra*, (PWS-Kent Publishing Company, Boston, 2004)
7. Seymour Lipschutz, *Linear Algebra*, 3rd edition, (McGraw Hill Book Company, 2001)

Code	Subject Title	Cr. Hrs	Semester
MATH-309	Complex Analysis – II	3	VI
Year	Discipline		
3	Mathematics-I,II		

Singularity and Poles

- Review of Laurent series
- Zeros, singularities
- Poles and residues

Contour Integration

- Cauchy's residue theorem
- Applications of Cauchy's residue theorem

Expansion of Functions and Analytic Continuation

- Mittag-Leffler theorem
- Weierstrass's factorization theorem
- Analytic continuation

Elliptic Functions

- Periodic functions
- Elliptic functions and its properties
- Weierstrass function $\wp(z)$
- Differential equation satisfied by $\wp(z)$
- Integral formula for $\wp(z)$
- Addition theorem for $\wp(z)$
- Duplication formula for $\wp(z)$
- Elliptic functions in terms of Weierstrass function with the same periods
- Quasi periodic functions: The zeta and sigma functions of Weierstrass
- Jacobian elliptic functions and its properties

Recommended Books

1. H. S. Kasana, *Complex Variables*: *Theory and Applications*, (Prentice Hall, 2005)
2. M. R. Spiegel, *Complex Variables*, (McGraw Hill Book Company, 1974)
3. Louis L. Pennisi, *Elements of Complex Variables*, (Holt, Linehart and Winston, 1976)
4. W. Kaplan, *Introduction to Analytic Functions*, (Addison-Wesley, 1966)
5. E. D. Rainville, *Special Functions*, (The Macmillan Company, New York, 1965)
6. E. T. Whittaker and G. N. Watson, *A Course of Modern Analysis*, (Cambridge University Press, 1958)

Code	Subject Title	Cr. Hrs	Semester
MATH-310	Mechanics	3	VI
Year	Discipline		
3	Mathematics-I,II		

Non Inertial Reference Systems

- Accelerated coordinate systems and inertial forces
- Rotating coordinate systems
- Velocity and acceleration in moving system: coriolis, centripetal and transverse acceleration
- Dynamics of a particle in a rotating coordinate system

Planar Motion of Rigid Bodies

- Introduction to rigid and elastic bodies, degrees of freedom, translations, rotations, instantaneous axis and center of rotation, motion of the center of mass
- Euler's theorem and Chasle's theorem
- Rotation of a rigid body about a fixed axis: moments and products of inertia, hoop or cylindrical shell, circular cylinder, spherical shell
- Parallel and perpendicular axis theorem
- Radius of gyration of various bodies

Motion of Rigid Bodies in Three Dimensions

- General motion of rigid bodies in space: Moments and products of inertia, inertia matrix
- The momental ellipsoid and equimomental systems
- Angular momentum vector and rotational kinetic energy
- Principal axes and principal moments of inertia
- Determination of principal axes by diagonalizing the inertia matrix

Euler Equations of Motion of a Rigid Body

- Force free motion
- Free rotation of a rigid body with an axis of symmetry
- Free rotation of a rigid body with three different principal moments
- The Eulerian angles, angular velocity and kinetic energy in terms of Euler angles, space cone
- Motion of a spinning top and gyroscopes- steady precession, sleeping top

Recommended Books

1. G. R. Fowles and G. L. Cassiday, *Analytical Mechanics*, 7th edition, (Thomson Brooks/Coley, USA, 2005)
2. M. R. Spiegel, *Theoratical Mechanics*, (McGraw Hill Book Company, Singapore, 1980)
3. F. P. Beer and E. Russell Johnston, Jr., *Vector Mechanics for Engineers –Statics and Dynamics*, (McGraw Hill Inc., 1977)
4. H. Goldstein, *Classical Mechanics*, (Addison-Wesley Publisihng Co., 1980)
5. C. F. Chorlton, *Text Book of Dynamics*, (Ellis Horwood, 1983).

Code	Subject Title	Cr. Hrs	Semester
MATH-311	Functional Analysis-I	3	VI
Year	Discipline		
3	Mathematics-I,II		

Metric Space

- Review of metric spaces
- Convergence in metric spaces
- Complete metric spaces
- Completeness proofs
- Dense sets and separable spaces
- No-where dense sets
- Baire category theorem

Normed Spaces

- Normed linear spaces
- Banach spaces
- Convex sets
- Quotient spaces
- Equivalent norms
- Linear operators
- Linear functionals
- Finite dimensional normed spaces
- Continuous or bounded linear operators
- Dual spaces

Inner Product Spaces

- Definition and examples
- Orthonormal sets and bases
- Annihilators, projections
- Hilbert space
- Linear functionals on Hilbert spaces
- Reflexivity of Hilbert spaces

Recommended Books

1. E. Kreyszig, *Introduction to Functional Analysis with Applications*, (John Wiley and Sons, 2004)
2. A. L. Brown and A. Page, *Elements of Functional Analysis*, (Van Nostrand Reinhold London, 1970)
3. G. Bachman and L. Narici, *Functional Analysis*, (Academic Press, New York, 1966)
4. F. Riesz and B. Sz. Nagay, *Functional Analysis*, (Dover Publications, Inc., New York, Ungar, 1965)
5. A. E. Taylor, *Functional Analysis*, (John Wiley and Sons, Toppan, 1958)

Code	Subject Title	Cr. Hrs	Semester
MATH-312	Ordinary Differential Equations	3	VI
Year	Discipline		
3	Mathematics-I,II		

First and Second Order Differential Equations

- Review of ordinary differential equations
- Techniques of solving second and higher differential equations

Sturm Liouville Systems

- Some properties of Sturm-Liouville equations
- Regular, periodic and singular Sturm-Liouville systems and its applications

Series Solutions of Second Order Linear Differential Equations

- Review of power series
- Series solution near an ordinary point
- Series solution near regular singular points.

Series Solution of Some Special Differential Equations

- Hypergeometric function $F(a, b, c; x)$ and its evaluation
- Series solution of Bessel equation
- Expression for $J_n(X)$ when n is half odd integer, Recurrence formulas for $J_n(X)$
- Series solution of Legendre equation
- Rodrigues formula for polynomial $P_n(X)$
- Generating function for $P_n(X)$
- Recurrence relations, orthogonal polynomials
- Orthogonality of Bessel functions
- Expansions of polynomials
- The three term recurrence relation

Recommended Books

1. E. D. Rainville, *Special Functions* (Macmillan and Company, 1971)
2. G. E. Andrews, R. Askey and R. Roy, *Special Functions* (Cambridge University Press, 2000)
3. D. G. Zill, *Advanced Engineering Mathematics* (Jones and Bartlett Publishers, 2005)
4. W. E. Boyce and R. C. Diprima, *Elementary Differential Equations and Boundary Value Problems* (John Wiley and Sons, 2005)
5. N. M. Temme, Special Functions, An Introduction to the Classical Functions of Mathematical Physics (John Wiley and Sons, 1996)
6. E. T. Whittaker, and G. N. Watson, A Course of Modern Analysis (Cambridge University Press, 1958)

Code	Subject Title	Cr. Hrs	Semester
MATH-401	**Set Theory**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Cardinality

- Equivalent sets, finite and infinite sets
- Denumerable sets
- Countable and uncountable sets
- Cardinal numbers, addition and multiplication of cardinals, Cartesian product as sets of functions
- Different types of infinity (Cantor's contribution)

Ordinality

- Partially ordered sets, Hasse diagrams
- Totally ordered sets
- Maximal and minimal elements
- Upper and lower bound
- Well-ordered sets
- Transfinite induction
- Ordinal numbers
- Multiplication of ordinal numbers

Axiom of Choice

- Well ordering theorem
- Zorn's lemma

Paradoxes in Set Theory

- Cantor's paradox, Russell's paradox and others.

Recommended Books:

- A. A. Fraenkal, Abstract Set Theory, (North-Holland Publishing, Amsterdam, 1966).
- Patrick Suppes, Axiomatic Set Theory, (Dover Publications, Inc., New York, 1972).
- P. R. Halmos, Naive Set Theory, (Van Nostrand, New York, 1960).
- B. Rotman and G. T. Kneebone, The Theory of Sets and Transfinite Numbers, (Oldbourne, London, 1968).
- Douglas Smith, Maurice Eggen and Richard St. Andre: A Transition to Advanced Mathematics, (Brooks/Cole, 2001).

BS (4 Years) for Affiliated Colleges

Code	Subject Title	Cr. Hrs	Semester
MATH-402	**Partial Differential Equations**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Introduction

- Review of ordinary differential equation in more than one variables
- Linear partial differential equations (PDEs) of the first order
- Cauchy's problem for quasilinear first order PDEs

PDEs of Second Order

- PDEs of second order in two independent variables with variable coefficients
- Linear transformation from one equation to another equation
- Normal form
- Cauchy's problem for second order PD Es in two independent variables

Adjoint Equation

- Adjoint operator
- Self adjoint equation and operator
- Linear PDEs in n independent variables
- Lagrange's identity
- Green's theorem for self adjoint operator

Boundary Value Problems

- Laplace equation
- Dirichlet problem for a circle
- Poisson's integral for a circle
- Solution of Laplace equation in Cartesian, cylindrical and spherical coordinates
- The wave equation in one dimension
- The wave equation in higher dimensions
- The heat equation
- Axially symmetric solutions

Recommended Books:

- I. N. Sneddon, Elements of Partial Differential Equations (Dover Publishing, Inc., 2006)
- R. Dennemyer, Introduction to Partial Differential Equations and Boundary Value Problems (McGraw Hill Book Company, 1968)
- M. Humi and W. B. Miller, Boundary Value Problem and Partial Differential Equations (PWS-Kent Publishing Company, Boston, 1991)
- C. R. Chester, Techniques in Partial Differential Equations (McGraw Hill Book Company, 1971)
- R. Haberman, Elementary Applied Partial Differential Equations, 2^{nd} edition (Prentice Hall Inc., New Jersey, 1987)
- E. Zauderer, Partial Differential Equations of Applied Mathematics (Wiley-Interscience, Englewood Cliff, New York, 2006)

Code	Subject Title	Cr. Hrs	Semester
MATH-403	**Numerical Analysis - I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Number Systems and Errors

- Round off errors and computer arithmetic
- Error estimation
- Floating point arithmetic

Solution of Non-Linear Equations

- Iterative methods and convergence: Bisection method, fixed point iterative method, Regula Falsi, Secant and Newton's method

Systems of Linear Equations

- Direct methods: Gaussian elimination method, Gauss-Jordan method, matrix inversion
- method, factorization (Doolittle, Crout and Cholesky) method and its various forms
- Iterative methods and convergence: Gauss-Jacobi method and Gauss-Seidel method
- Ill-condition system and condition number
- Eigen values and eigenvectors
- Power and Rayleigh quotient method

Interpolation and Polynomial Approximation

- Difference operators
- Interpolation with unequal intervals: Lagrange's interpolation formula, Newton's divided difference formula, error in polynomial interpolation
- Interpolation with equal intervals: Gregory Newton forward/backward interpolation formula, error in polynomial interpolation
- Central difference interpolation formulae: Gauss's forwar d/backward interpolation formula, Stirling's formula, Laplace Everett's formula, Bessel's formula

Recommended Books:

- Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 6th edition, (Addison-Wesley Pearson Education, 2003)
- Richard L. Burden and J. Douglas Faires, Numerical Analysis, 6th edition, (Brooks/Cole Publishing Company,1997)
- John H. Mathews, Numerical Methods for Mathematics, 3rd edition (Prentice Hall International, 2003)
- V. N. Vedamurthy and N. Ch. S. N. Iyenger, Numerical Methods, (Vikas Publishing House Pvt. Ltd, 2002)
- Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, 3rd edition, (McGraw Hill International Edition, 1998)

Code	Subject Title	Cr. Hrs	Semester
MATH-404	**Mathematical Statistics-I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Probability Distributions

- The postulates of probability
- Some elementary theorems
- Addition and multiplication rules
- Baye's rule and future Baye's theorem
- Random variables and probability functions.

Discrete Probability Distributions

- Uniform, Bernoulli and Binomial distribution
- Hypergeometric and geometric distribution
- Negative binomial and Poisson distribution

Continuous Probability Distributions

- Uniform and exponential distribution
- Gamma and beta distributions
- Normal distribution

Mathematical Expectations

- Moments and moment generating functions
- Moments of binomial, hypergeometric, Poisson, gamma, beta and normal distributions

Recommended Books:

- J. E. Freund, Mathematical Statistics, (Prentice Hall Inc., 1992)
- Hogg and Craig, Introduction to Mathematical Statistics , (Collier Macmillan, 1958)
- Mood, Greyill and Boes, Introduction to the Theory of Statistics, (McGraw Hill)
- R. E. Walpole, Introduction to Statistics, 3rd edition, (Macmillan Publishing Company London, 1982)
- M. R. Spiegel and L. J. Stephens, Statistics, (McGraw Hill Book Company, 1984)

Code	Subject Title	Cr. Hrs	Semester
MATH-405	**Fortran Programming**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Simple Fortran 90 Programs

- Writing a program
- Input statement
- Some FORTRAN 90 program examples

Numeric Constants and Variables

- Constants
- Scalar variables
- Declaring variable names
- Implicit declaration
- Named constants

Arithmetic Expressions

- Arithmetic operators and modes of expressions
- Integer expressions
- Real expressions
- Procedure of operations in expressions
- Assignment statements
- Defining variables
- Mixed mode expressions
- Intrinsic functions

Conditional Statements

- Relational operators
- The block if construct
- Example programs using if structures

Implementing Loops in Programs

- The block do loop
- Count controlled do loop

Logical Expressions and More Control Statements

- Logical constants, variables and expressions
- Precedence rules for logical operators
- The case statement

Functions and Subroutines

- Function subprograms
- Syntax rules for function subprograms
- Generic functions
- Subroutines

Defining and Manipulating Arrays

- Arrays variables
- Use of multiple subscripts
- Do type notation for input/output statements
- Initializing arrays
- Use of arrays in do loops
- Whole array operations

Elementary Format Specifications

- Format description for numerical data; read statement
- Format description for print statement
- Multi-record formats
- Printing character strings

Recommended Books:

- Michel Metcalf, John Reid and Malcolm Cohen, Fortran 95/2003 Explained, (Oxford University Press, 2004)
- V. Rajaraman, Computer Programming in Fortran 90 and 95, (Prentice Hall of India, New Delhi, 1999)
- Larry Nyhoff and Sanford Leestma, Fortran 90 for Engineers and Scientists , (Prentice Hall, 1997)
- Stephen J. Chapman, Introduction to Fortran 90/95, (Mc Graw-Hill International Edition, 1998)

Code	Subject Title	Cr. Hrs	Semester
MATH-406	**Group Theory - II**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Automorphisms and Products in Groups

- Characteristic and fully invariant subgroups
- Normal products of groups
- Holomorph of a group

Permutation Groups

- Symmetric or permutation group
- Permutability of permutations
- Transposions
- Generators of the symmetric and alternating group
- Cyclic permutations and orbits, the alternating group
- Generators of the symmetric c and alternating groups
- Simplicity of A, n 5
- The stabiliser subgroups

Series in Groups

- Series in groups
- Zassenhaus lemma
- Normal series and their refinements
- Composition series

Recommended Books:

- J. Rotman, The Theory of Groups, 2nd edition, (Allyn and Bacon, London, 1978)
- J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-Weseley Publishing Co., 2003)
- I. N. Herstein, Topics in Algebra, (Xerox Publishing Company Mass, 1972)
- J. A. Gallian, Contemporary Abstract Algebra, 4th edition, (Narosa Publishers, 1998)
- J. S. Rose, A Course on Group Theory, (Dover Publications, New York, 1994)
- K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Code	Subject Title	Cr. Hrs	Semester
MATH-407	**Ring Theory**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Ring Theory

- Construction of new rings
- Direct sums, polynomial rings
- Matrix rings
- Divisors, units and associates
- Unique factorisation domains
- Principal ideal domains and Euclidean domains

Field Extensions

- Algebraic and transcendental elements
- Degree of extension
- Algebraic extensions
- Reducible and irreducible polynomials
- Roots of polynomials

Recommended Books:

- I. N. Herstein, Topics in Algebra, (Xerox Publishing Company Mass, 1972)
- B. Hartley and T. O. Hauvkes, Rings, Modules and Linear Algebra, (Chapmann and Hall
- Ltd., London, 1970)
- R. B. Allenly, Rings, Fields and Groups:An Introduction to Abstract Algebra, (Edward
- Arnold, 1985)
- J. Rose, A Course on Rings Theory, (Cambridge University Press, 1978)
- G. Birkhoff and S. Maclane, A Survey of Modern Algebra, (Macmillan, New York, 1964)

Code	Subject Title	Cr. Hrs	Semester
MATH-408	**Number Theory-I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Congruences

- Elementary properties of prime numbers
- Residue classes and Euler's function
- Linear congruences and congruences of higher degree
- Congruences with prime moduli
- The theorems of Fermat, Euler and Wilson

Number-Theoretic Functions

- Möbius function
- The function [x], the symbols O and their basic properties

Primitive roots and indices

- Integers belonging to a given exponent
- Composite moduli, primitive roots modulo a prime
- Determination of integers having primitive roots indices

Recommended Books:

- W. J. Leveque, Topics in Number Theory, (Vols. I and II, Addison-Wesley Publishing
- Co., 1956)
- Tom M. Apostol, Introduction to Analytic Number theory, (Springer International,1998)
- David M. Burton, Elementary Number Theory, 6th edition, (McGraw Hill Company,2007)
- A. Andrew, The Theory of Numbers, (Jones and Barlett Publishers London, 1995)
- Harry Pollard, The Theory of Algebraic Numbers , (John Wiley and Sons, Inc, 1950)

Code	Subject Title	Cr. Hrs	Semester
MATH-409	**Quantum Mechanics-I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Inadequacy of Classical Mechanics

- Black body radiation
- Photoelectric effect
- Compton effect
- Bohr's theory of atomic structure
- Wave-particle duality
- The de Broglie postulate
- Heisenberg uncertainty principle

The Postulates of Quantum Mechanics: Operators, Eigenfunctions and Eigenvalues

- Observables and operators
- Measurement in quantum mechanics
- The state function and expectation values
- Time development of the state f unction (Schrödinger wave equation)
- Solution to the initial-value problem in quantum mechanics
- Parity operators

Preparatory Concepts: Function Spaces and Hermitian Operators

- Particle in a box
- Dirac notation
- Hilbert space
- Hermitian operators
- Properties of Hermitian operators

Additional One-Dimensional Problems: Bound and Unbound States

- General properties of the 1-di mensional Schrodinger equation
- Unbound states
- One-dimensional barrier problems
- The rectangular barrier: Tunneling

Recommended Books:

- H. D. Dehmen, the Picture Book of Quantum Mechanics (Springer, 2001).
- H. F. Hameka, Quantum Mechanics: A Conceptual Approach (Wiley-IEEE, 2004).
- R. L. Liboff, Introductory Quantum Mechanics (Addison-Wesley Publishing Co., 2003).
- V. K. Thankappan, Quantum Mechanics (New Age Publishers, 1993).
- D. R. Bès, Quantum Mechanics: A Modern and Concise Introductory Course (Springer, 2004).

Code	Subject Title	Cr. Hrs	Semester
MATH-410	**Analytical Dynamics**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Lagrange's Theory of Holonomic Systems

- Generalized coordinates
- Holonomic and non-holonomic systems
- D'Alembert's principl e, d-delta rule
- Lagrange equations
- Generalization of Lagrange equations
- Quasi-coordinates
- Lagrange equations in quasi-coordinates
- First integrals of Lagran ge equations of motion
- Energy integral

Hamilton's Theory

- Hamilton's principle
- Generalized momenta and phase space
- Hamilton's equations
- Ignorable coordinates, Routhian function
- Derivation of Hamilton's equations from avariational principle
- The principle of least action

Lagrange's Theory of Non-Holonomic Systems

- Lagrange equations for non-holonomic systems with and without Lagrange multipliers
- Hamilton's Principle for non-holonomic systems

Canonical Transformations

- The equations of canonical transformations
- Examples of canonical transformations
- The Lagrange and Poisson brackets
- Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation

Hamilton-Jacobi Theory

- The Hamilton-Jacobi equation for Hamilton's principal function
- The harmonic oscillator problem as an example of the Hamilton-Jacobi method
- The Hamilton-Jacobi equation for Ha milton's characteristic function
- Separation of variables in the Hamilton-Jacobi equation

Recommended Books:

- D. T. Greenwood, Classical Dynamics (Dover, 1997).
- F. Chorlton, Chorlton Text Book of Dynamics (Ellis Horwood, 1983).
- H. Goldstein, C. P. Poole and J. L. Safko, Classical Mechanics (Addison-Wesley Publishing Co., 2003).
- S. D. Lindenbaum, Analytical Dynamics: Course Notes (World Scientific, 1994).
- E. J. Saleton and J. V. José, Classical Dynamics: A Contemporary Approach (Cambridge,
- 1998).
- J. B. Marion and S. T. Thornton, Classical Dynamics of Particles and Systems (Thomson
- Learning, 2003).

Code	Subject Title	Cr. Hrs	Semester
MATH-411	**Electromagnetic Theory - I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Electrostatic Fields

- Coulomb's law, the electric fi eld intensity and potential
- Gauss's law and deductions, Poi sson and Laplace equations
- Conductors and condensers
- Dipoles, the linear quadrupole
- Potential energy of a charge distribution, Dielectrics
- The polarization and the displacement vectors
- General solutions of Laplace's equation
- Solutions of Laplace's equati on in spherical coordinates
- Legendre's equation, Le gendre's polynomials

Magnetostatic Fields

- The Magnetostatic law of force
- The magnetic induction
- The Lorentz force on a point charge moving in a magnetic field
- The divergence of the magnetic field
- The vector potential
- The conservation of charge and the equation of continuity
- The Lorentz condition
- The curl of the magnetic field
- Ampere's law and the scalar potential

Steady and Slowly Varying Currents

- Electric current, linear conductors
- Conductivity, resistance
- Kirchhoff's laws
- Current density vector
- Magnetic field of straight and circular current
- Magnetic flux, vector potential
- Forces on a circuit in magnetic field

Recommended Books:

- G. E. Owen, Introduction to Electromagnetic Theory (Dover, 2003).
- D. Corrison and P. Lorrison, Introduction to Electroma gnetic Fields and Waves (W.H.Freeman and Company, London, 1962).
- J. R. Reitz, F. J. Milford and R. W. Christy, Foundations of Electromagnetic Theory (Addison-Wesley Publishing Co., 1993).
- J. D. Jackson, Classical Electrodynamics (Wiley, 1999).
- D. J. Griffiths, Introduction to Electrodynamics (Prentice-Hall, 1999).

Code	Subject Title	Cr. Hrs	Semester
MATH-412	**Operations Research - I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Linear Programming

- Linear programming, formulations and graphical solution
- Simplex method
- M-Technique and two-phase technique
- Special cases
- Duality and Sensitivity Analysis
- The dual problem, primal-dual relationships
- Dual simplex method
- Sensitivity and postoptimal analysis

Transportation Models

- North-West corner
- Least-Cost and Vogel's approximations methods
- The method of multipliers
- The assignment model
- The transhipment model
- Network minimization

Recommended Books:

- Hamdy A. Taha, Operations Research - An Introduction , (Macmillan Publishing Company
- Inc., New York, 1987)
- B. E. Gillett, Introduction to Operations Research , (Tata McGraw Hill Publishing Company Ltd., New Delhi)
- F. S. Hillier and G. J. Liebraman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974)
- C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979)

Code	Subject Title	Cr. Hrs	Semester
MATH-413	**Theory of Approximation and Splines - I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Euclidean Geometry

- Basic concepts of Euclidean geometry
- Scalar and vector functions
- Barycentric coordinates
- Convex hull, matrices of affine maps: translation, rotation, scaling, reflection and shear

Approximation using Polynomials

- Curve Fitting : Least squares line fitting, least square s power fit, data linearization method for exponential functions, nonlinear least-squares method for exponential functions, transformations for data linearization, linear least squares, polynomial fitting

- Interpolation : Basic concepts of interpolation, Lagrange's method, error terms and error bounds of Lagrange's method, divided differences method, Newton polynomials, error terms and error bounds of Newton polynomials, central difference interpolation formulae; Gauss's forward interpolation formula, Gauss' s backward interpolation formula, Hermite's methods.

Recommended Books:

- David A. Brannan, Geometry, (Cambridge University Press, 1999).
- Gerald Farin, Curves and Surfaces for Computer Aided Geometric Design: A Practical
- Guide, 5th edition, (Academic Press. Inc., 2002).
- Richard H. Bartels, John C. Bealty, and John C. Beatty, An Introduction to Spline for use in Computer Graphics and Geometric Modeling, (Morgan Kaufmann Publisher 2006).
- John H. Mathews, Numerical Methods for Mathematics, Science and Engineering, 2nd Edition (Prentice-Hall International Editions, 1992).
- Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers 3rd edition, (McGraw Hill International Edition, 1998).

Code	Subject Title	Cr. Hrs	Semester
MATH-414	**Functional Analysis - II**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Compact Normed Spaces

- Completion of metric spaces
- Completion of normed spaces
- Compactification
- Nowhere and everywhere dense sets and category
- Generated subspaces and closed subspaces
- Factor Spaces
- Completeness in the factor spaces

Complete Orthonormal set

- Complete orthonormal sets
- Total orthonormal sets
- Parseval's identity
- Bessel's inequality

The Specific geometry of Hilbert Spaces

- Hilbert spaces
- Bases of Hilbert spaces
- Cardinality of Hilbert spaces
- Linear manifolds and subspaces
- Othogonal subspaces of Hilbert spaces
- Polynomial bases in 2L spaces

Recommended Books:

- G. Bachman and L. Narici, Functional Analysis, (Academic Press, New York, 1966)
- A. E. Taylor, Functional Analysis, (John Wiley and Sons, Toppan, 1958)
- Helmberg, Introduction to Spectral theory in Hilbert spaces , (North Holland Publishing Company, 1969)
- E. Kreyszig, Introduction to Functional A nalysis with Applications, (John Wiley and Sons,
- 2004)
- F. Riesz and B. Sz. Nagay, Functional Analysis, (Dover Publications, Inc., New York, Ungar, 1965)
- W. Rudin, Functional Analysis, 2^{nd} edition, (McGraw Hill Book Company, New York, 1991)

Code	Subject Title	Cr. Hrs	Semester
MATH-415	**Fluid Mechanics-I**	**3**	**VII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Conservation of Matter

- Introduction
- Fields and continuum concepts
- Lagrangian and Eulerian specifications
- Local, convective and total rates of change
- Conservation of mass
- Equation of continuity
- Boundary conditions

Nature of Forces in a Fluid Field and their Effects

- Surface and body forces
- Stress at a point
- Viscosity and Newt on's viscosity law
- Viscous and inviscid flows
- Laminar and turbulent flows
- Compressible and incompressible flows

Irrotational Fluid Motion

- Velocity potential from an irrotational velocity field
- Streamlines
- Vortex lines and vortex sheets
- Kelvin's minimum energy theorem
- Conservation of linear momentum
- Bernoulli's theorem and its applications
- Circulations, rate of change of circulation (Kelvin's theorem)
- Aaxially symmetric motion
- Stokes's stream function

Two-dimensional Motion

- Stream function
- Complex potential and complex velocity, Uniform flows
- Sources, sinks and vortex flows
- Flow in a sector
- Flow around a sharp edge, Flow due to a doublet

Recommended Books:

- H. Schlichting, K. Gersten, E. Krause and H. Oertel, Jr.: Boundary-Layer Theory, 8th edition (Springer, 2004).
- Yith Chia-Shun: Fluid Mechanics (McGraw Hill, 1974).
- I. L. Distsworth: Fluid Mechanics (McGraw Hill, 1972).
- F. M. White: Fluid Mechanics (McGraw Hill, 2003).
- I. G. Curie: Fundamentals of Mechanics of Fluids, Third edition (CRC, 2002).
- R. W. Fox, A. T. McDonald and P. J. Pritchard: Introduction to Fluid Mechanics (John Wiley and Sons, 2003).

Code	Subject Title	Cr. Hrs	Semester
MATH-416	**Measure Theory and Lebesgue Integration**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Measurable Sets

- Outer measure, Lebesgue measure
- Lebesgue measurable sets
- Borel sets
- Non measurable sets

Measurable Functions

- Lebesgue measurable functions
- Simple functions, characteristic functions
- Borel measurable function
- Littlewood three principle

The Lebsegue Integration

- Review of the Riemann integral
- Lebsegue integral
- Integral of a non negative function
- Integral of measurable functions
- Convergence in measure

Recommended Books:

- D. Smith, M. Eggen and R. St. Andre, A Transition to Advanced Mathematics, (Brooks, 2001)
- Seymour Lipshcutz, Set Theory and Related Topics, (Mc-Graw Hill Book Company, 1999)
- H. L. Royden, Real Analysis, (Macmillam, 1968)
- D. L. Cohan, Measure Theory, (Bir Khauser, 1980)
- P.R. Halmos, Measure Theory, (Von Nostrand, New York, 1950)

Code	Subject Title	Cr. Hrs	Semester
MATH-417	**Methods of Mathematical Physics**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Fourier Methods

- The Fourier transform
- Fourier analysis of generalized functions
- The Laplace transform
- Hankel transforms for the solution of PDE and their application to boundary value problems

Green's Functions and Transform Methods

- Expansion for Green's functions
- Transform methods
- Closed form Green's functions

Perturbation Techniques

- Perturbation methods for algebraic equations
- Perturbation methods for differential equations

Variational Methods

- Euler-Lagrange equations
- Integrand involving one, two, three and n variables
- Special cases of Euler-Lagranges equations
- Necessary conditions for existence of an extremum of a functional
- Constrained maxima and minima

Recommended Books:

- D. L. Powers, Boundary Value Problems and Partial Differential Equations, 5th edition (Academic Press, 2005)
- W. E. Boyce, Elementary Differential Equations, 8th edition, (John Wiley and Sons, 2005)
- M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, Problems and Exercises in the Calculus of Variations, (Imported Publications, Inc., 1985)
- J. W. Brown and R. V. Churchill, Fourier Series and Boundary Value Problems (McGraw Hill, 2006)
- A. D. Snider, Partial Differential Equati ons: Sources and Solutions (Prentice Hall Inc., 1999)

Code	Subject Title	Cr. Hrs	Semester
MATH-418	**Numerical Analysis - II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Numerical Differentiation

- Derivatives using: Lagrange's interpolation formula, Newton's divided difference formula, Gregory Newton forward/backward interpolation formula, Gauss's forward / backward
- interpolation formula, Stirling's formula, Laplace Everett's formula, Bessel's formula

Numerical Integration

- Newton-Cotes formulae
- Trapezoidal rule, Simpson rule, Weddle's rule, Boole's rule
- Errors in quadrature formulae
- Gaussian quadrature formulae

Formulation of Difference Equations

- Analogy of difference equations
- Linear homogeneous difference equations with constant coefficients
- Linear non-homogeneous difference equations with constant coefficients

Ordinary Differential Equations

- Introduction to ODEs
- Taylor's series method: Simultaneous first order differential equations, higher order differential equations
- Euler's, improved Euler's, modified Euler's and Runge-Kutta methods with error analysis
- Predictor-corrector methods for solving initial value problems

Recommended Books:

- Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 6th edition, (Addison-Wesley Publishing Co. Pearson Education, 2003)
- Richard L. Burden and J. Douglas Faires, Numerical Analysis , 6th edition, (Brooks/Cole
- Publishing Company,1997)
- John H. Mathews, Numerical Methods for Mathematics, Science and Engineering, 3rd edition (Prentice Hall International, 2003)
- V. N. Vedamurthy and N. Ch. S. N. Iyenger, Numerical Methods , (Vikas Publishing House Pvt. Ltd, 2002)
- Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers 3rd edition,
- (McGraw Hill International Edition, 1998)

Code	Subject Title	Cr. Hrs	Semester
MATH-419	**Mathematical Statistics - II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Functions of Random Variables

- Distribution function technique
- Transformation technique: One variable, several variables
- Moment-generating function technique

Sampling Distributions

- The distribution of the mean
- The distribution of the m ean: Finite populations
- The Chi-Square distribution.
- The t distribution
- The F distribution

Regression and Correlation

- Linear regression
- The methods of least squares
- Normal regression analysis
- Normal correlation analysis
- Multiple linear regression
- Multiple linear regression (matrix notation)

Recommended Books:

- J. E. Freund, Mathematical Statistics, (Prentice- Hall Inc., 1992).
- Hogg and Craig, Introduction to Mathema tical Statistics, (Collier Macmillan, 1958).
- Mood, Greyill and Boes, Introduction to the Theory of Statistics, (McGraw Hill).
- R. E. Walpole, Introduction to Statistics, 3rd edition, (Macmillan Publishing Company London, 1982)
- M. R. Spiegel, L. J. Stephens, Statistics, (McGraw Hill Book Company, 1984)

Code	Subject Title	Cr. Hrs	Semester
MATH-421	**Computer Applications**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Flow Chart, Algorithm and Programming of the following Numerical Methods

- System of linear equations Jacobi's iterative method, Gauss-Seidel method
- Solutions of non-linear equations
- Bisection method, Newton-Raphson method, Secant method, Regula Falsi method
- Interpolation Langrage interpolation, Newton's divided and forward difference interpolation
- Numerical integration:
- Rectangular rule, Trapezoidal rule, Si mpson's rule, Booles rule, Weddles rule
- Differential equations:
  Euler's method, Runge- Kutta methods, predictor-corrector methods
- Mathematica
- Introduction of mathematica, num erical calculations, algebraic calculations, symbolic and numerical mathematics, numbers, mathemati cal functions, algebraic manipulations, manipulating equations, series, limits and residues, linear algebra, graphs

Recommended Books:

- Michel Metcalf, John Reid and Malcolm Cohen, Fortran 95/2003 Explained, (Oxford University Press, 2004)
- Stephen Wolfram, The Mathematica, 3rd edition, (Cambridge University Press 1996)
- V. Rajaraman, Computer Programming in Fortran 90 and 95, (Prentice Hall of India, New Delhi, 1999)
- Roman E. Maeder, Computer Science with Mathematics, (Cambridge University Press, 2000)
- Martha L. Abell, James P. Braselton, The Mathematica Handbook , (Academic Press Inc., 1992)

Code	Subject Title	Cr. Hrs	Semester
MATH-422	**Group Theory - III**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Solvable Groups

- Solvable groups, definition and examples
- Theorems on solvable groups
- Super-solvable groups

Nilpotent Groups

- Characterisation of fin ite nilpotent groups
- Upper and lower central series
- Frattini subgroups, free groups, basic theorems
- Definition and examples of free products of groups

Linear Groups

- Linear groups, types of linear groups
- Representation of linear groups
- Group algebras and representation modules

Recommended Books:

- J. Rotman, The Theory of Groups , 2nd edition, (Allyn and Bacon, London, 1978)
- J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-Wesley Publishing Co., 2003)
- H. Marshall, The Theory of Groups, (Macmillan, 1967)
- J. A. Gallian, Contemporary Abstract Algebra , 4th edition, (Narosa 1998)
- J. S. Rose, A Course on Group Theory , (Dover Publications, New York, 1994)
- K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Code	Subject Title	Cr. Hrs	Semester
MATH-423	**Theory of Modules**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Modules

- Definition and examples
- Submodules
- Homomorphisms
- Quotient modules
- Direct sums of modules.
- Finitely generated modules
- Torsion modules
- Free modules
- Basis, rank and endomorphisms of free modules
- Matrices over rings and their connection with the basis of a free module
- A module as the direct sum of a free and a torsion module

Recommended Books:

- J. Rotman, The Theory of Groups , 2nd edition, (Allyn and Bacon, London, 1978)
- J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, (Addison-Weseley Publishing Co., 2003)
- H. Marshall, The Theory of Groups, (Macmillan, 1967).
- J. A. Gallian, Contemporary Abstract Algebra, 4th edition, (Narosa Publisihng House, 1998)
- J. S. Rose, A Course on Group Theory , (Dover Publications, New York, 1994)
- K. Hoffman, Linear Algebra, 2nd edition, (Prentice Hall, 1971)

Code	Subject Title	Cr. Hrs	Semester
MATH-424	**Number Theory - II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Quadratic Residues

- Composite moduli, Legendre symbol
- Law of quadratic reciprocity
- The Jacobi symbol
- Diophantine Equations
- Equations and Fermat's conjecture for n = 2, n = 4

Algebraic Number Theory

- Polynomials over a field
- Divisibility properties of polynomials
- Gauss's lemma
- The Einstein irreducibility criterion
- Symmetric polynomials
- Extensions of a field
- Algebraic and transcendental numbers
- Bases and finite extensions, properties of finite extensions
- Conjugates and discriminants
- Algebraic integers in a quadratic field, integral bases
- Units and primes in a quadratic field
- Ideals, arithmetic of ideals in an algebraic number field
- The norm of an ideal, prime ideals, units of algebraic number field

Recommended Books:

- W. J. Leveque, Topics in Number Theory, Vols. I and II (Addison-Wesley Publishing Co. Publishing Co., 1956)
- Tom M. Apostol, Introduction to Analytic Number Theory, (Springer International, 1998) 50
- David M. Burton, Elementary Number Theory, 6th edition, (McGraw Hill Company, 2007)
- A. Andrew, The Theory of Numbers, (Jones and Barlett Publishers London, 1995)
- Harry Pollard, The Theory of Algebraic Numbers , (John Wiley and Sons, 1950)

Code	Subject Title	Cr. Hrs	Semester
MATH-425	**Quantum Mechanics - II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Harmonic Oscillator and Problems in Three-Dimensions

- The harmonic oscillator
- Eigenfunctions of the harmonic oscillator
- The harmonic oscillator in momentum space
- Motion in three dimensions
- Spherically symmetric pote ntial and the hydrogen atom

Angular Momentum

- Basic properties
- Eigenvalues of the angular momentum operators
- Eigenfunctions of the orbital angular momentum operators L2 and Lz
- Commutation relations between components of angular momentum and their representation in spherical polar coordinates

Scattering Theory

- The scattering cross-section
- Scattering amplitude
- Scattering equation
- Born approximation
- Partial wave analysis

Perturbation Theory

- Time independent perturbation of no n-degenerate and degenerate cases
- Time-dependent perturbations

Recommended Books:

- R. L. Liboff, Introductory Quantum Mechanics (Addison-Wesley Publishing, 2003)
- H. D. Dehmen, The Picture Book of Quantum Mechanics (Springer, 2001)
- H. F. Hameka, Quantum Mechanics: A Conceptual Approach (Wiley-IEEE, 2004)
- V. K.Thankappan, Quantum Mechanics (New Age Publishers, 1993).
- D. R. Bès, Quantum Mechanics: A Modern and Concise Introductory Course (Springer,
- 2004)

Code	Subject Title	Cr. Hrs	Semester
MATH-426	**Special Theory of Relativity**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Introduction

- Fundamental concepts
- Derivation of Special Relativity
- Einstein's formulation of special relativity
- The Lorentz transformation
- Length contraction, time dilation and simultaneity
- The velocity addition formulae
- Three dimensional Lorentz transformations

The Four-Vector Formulation of Special Relativity

- The four-vector formalism
- The Lorentz transformations in 4-vectors
- The Lorentz and Poincare groups
- The null cone structure
- Proper time

Applications of Special Relativity

- Relativistic kinematics
- The Doppler shift in relativity
- The Compton effect
- Particle scattering
- Binding energy, particle produc tion and particle decay

Electromagnetism in Special Relativity

- Review of electromagnetism
- The electric and magnetic field intensities
- The electric current
- Maxwell's equations and electromagnetic waves
- The four-vector formulation of Maxwell's equations

Recommended Books:

- M. Saleem and M. Rafique, Special Relativity (Ellis Horwood, 1992)
- W. G. V. Rosser, Introductory Special Relativity (Taylor & Francis, 1991)
- W. Ringler, Introduction to Special Relativity (Oxford, 1991)
- A. Qadir, An Introduction to Special Theory of Relativity (World Scientific 1989)
- G. Barton, Introduction to the Relativity Principle (Wiley, 1999)
- W. Rindler, Introduction to Special Relativity (Clarendon Press, Oxford, 1991)

Code	Subject Title	Cr. Hrs	Semester
MATH-427	**Electromagnetic Theory - II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Steady and Slowly Varying Currents

- The Faraday induction law
- Induced elecromotance in a moving system
- Inductance and induced electromotance
- Energy stored in a magnetic field

The Equations of Electromagnetism

- Maxwell's equations in free space and material media
- Solution of Maxwell's equations

Electromagnetic Waves

- Plane electromagnetic waves in ho mogeneous and isotropic media
- The Poynting vector in free space
- Propagation plane electromagnetic waves in non-conductors
- Propagation plane electromagnetic waves in conducting media
- Reflection and refraction of plane waves
- Guided waves; coaxial line; hollow rectangular wave guide
- Radiation of electromagnetic waves
- Electromagnetic field of a moving charge

Recommended Books:

- J. R. Reitz, F. J. Milford and R. W. Christy, Foundations of Electromagnetic Theory (Addison-Wesley Publishing Co., 1993)
- D. Corrison and P. Lorrison, Introduction to Electroma gnetic Fields and Waves (W.H. Freeman and Company, London, 1962).
- C.G. Someda, Electromagnetic Waves (CRC, 2006).
- J. D. Jackson, Classical Electrodynamics (Wiley, 1999).
- J. V. Stewart, Intermediate Electromagnetic Theory (World Scientific, 2001).
- G. E. Owen, Introduction to Electromagnetic Theory (Dover, 2003).

Code	Subject Title	Cr. Hrs	Semester
MATH-428	**Operations Research - II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

- Shortest-Route algorithms for acyclic networks
- Maximal-flow problem
- Matrix definition of LP problem
- Revised simplex method, bounded variables
- Decomposition algorithm
- Parametric linear programming
- Applications of integer programming
- Cutting-plane algorithms
- Branch-and-bound method
- Zero-one implicit enumeration
- Elements of dynamic programming
- Problem of dimensionality
- Programmes by dynamic programming

Recommended Books:

- Hamdy A. Taha, Operations Research-An Introduction, (Macmillan Publishing Company Inc., New York, 1987)
- B. E. Gillett, Introduction to Operations Research , (Tata McGraw Hill Publishing Company Ltd., New Delhi)
- F. S. Hillier and G. J. Liebraman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974)
- C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979)

Code	Subject Title	Cr. Hrs	Semester
MATH-429	**Theory of Approximation and Splines - II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Parametric Curves (Scalar and Vector Case)

- Cubic algebraic form
- Cubic Hermite form
- Cubic control point form
- Bernstein Bezier cubic form
- Bernstein Bezier general form
- B-Spline cubic form
- Matrix forms of parametric curves
- Rational quadratic form
- Rational cubic form
- Tensor product surface, Bernstein Bezier cubi c patch, quadratic by cubic Bernstein Bezier
- patch, Bernstein Bezier quartic patch
- Convex hull property
- Affine invariance property
- Variation diminishing property
- Algorithms to compute Bernstein Bezier form

Spline Functions

- Introduction to splines
- Cubic Hermite splines
- End conditions of cubic splines: cl amped conditions, natural conditions, 2nd Derivative conditions, periodic conditions, not a knot conditions
- General Splines: natural splines, periodic splines
- Truncated power function, representation of spline in terms of truncated power functions, examples

Recommended Books:

- Gerald Farin, Curves and Surfaces for Computer Aided Geometric Design: A Practical Guide, 5th edition (Academic Press. Inc., 2002).
- I. D. Faux, Computational Geometry for Design and Manufacture, (Ellis Horwood, 1979).
- Richard H. Bartels, John C. Bealty, and John C. Beatty, An Introduction to Spline for use in Computer Graphics and Geometric Modeling , (Morgan Kaufmann Publisher, 2006).
- Carl de Boor, A Practical Guide to Splines, (Springer Verlag, 2001).
- Larry L. Schumaker, Spline Functions: Basic Theory, (John Wiley and Sons, 1993).

Code	Subject Title	Cr. Hrs	Semester
MATH-430	**Functional Analysis - III**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Semi-norms

- Semi norms, locally convex Spaces
- Quasi normed linear spaces
- Bounded linear functionals
- Hahn Banach theorem

Conjugate spaces

- Second conjugate space of pl
- The Riesz representation theorem for linear functionals on a Hilbert spaces
- Conjugate space of b a C ,
- A representation theorem for bounded linear functionals on b a C ,

Uniform Boundedness

- Weak convergence
- The Principle of uniform boundedness
- Consequences of the principle of uniform boundedness
- Graph of a mapping and closed graph theorem

Linear transformation and complete continuity

- The closure of linear transformation
- The class of linear transforma tions that admit a closure

Recommended Books:

- G. Bachman and L. Narici, Functional Analysis, (Academic Press, New York, 1966)
- A. E. Taylor, Functional Analysis, (John Wiley and Sons, Toppan, 1958)
- G. Helmberg , Introduction to Spectral theory in Hilbert spaces , (N. H. Publishing Company 1969)
- E. Kreyszig, Introduction to Functional A nalysis with Applications, (John Wiley and Sons,
- 2004)
- F. Riesz and B. Sz. Nagay, Functional Analysis, (Dover Publications, New York, Ungar, 1965)
- W. Rudin, Functional Analysis, 2nd edition, (McGraw Hill Book Company, New York, 1991)

Code	Subject Title	Cr. Hrs	Semester
MATH-431	**Fluid Mechanics-II**	**3**	**VIII**
Year	Discipline		
4	**Mathematics**		

Objectives:

Two and Three-Dimensional Potential Flows

- Circular cylinder without circulation
- Circular cylinder with circulation
- Blasius theorem
- Kutta condition and the flat-plate airfoil
- Joukowski airfoil
- Vortex motion
- Karman's vortex street
- Method of images
- Velocity potential
- Stoke's stream function
- Solution of the Potential equation
- Uniform flow
- Source and sink
- Flow due to a doublet

Viscous Flows of Incompressible Fluids

- Constitutive equations
- Navier-Stokes's equations, exact solutions of Navier-Stokes's equations
- Steady unidirectional flow
- Poiseuille flow
- Couette flow
- Flow between rotating cylinders
- Stokes' first problem
- Stokes' second problem

Simplified Approach to Fluid Flow Problems

- Similarity from a differential equation
- Dimensional analysis
- One dimensional, steady compressible flow

Recommended Books:

- H. Schlichting, K. Gersten, E. Krause and H. Oertel, Jr.: Boundary-Layer Theory, 8th edition (Springer, 2004)
- Yith Chia-Shun: Fluid Mechanics (McGraw Hill, 1974)
- I. L. Distsworth: Fluid Mechanics (McGraw Hill, 1972)
- F. M. White: Fluid Mechanics (McGraw Hill, 2003)
- I. G. Curie: Fundamentals of Mechanics of Fluids, Third edition (CRC, 2002)
- R. W. Fox, A. T. McDonald and P. J. Pritchard: Introduction to Fluid Mechanics (John Wiley and Sons, 2003)