

SHRI GURU RAM RAI UNIVERSITY

(Estd. By Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 3 of 2017)
PATEL NAGAR, DEHRADUN-248001, UTTARAKHAND, INDIA



SYLLABUS (2017)

PROGRAMME/COURSE: B.SC. MATHEMATICS

B.SC. MATHEMATICS (SEMESTER I)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BMTC-101	Differential calculus	06	30	70	100
	Total	06	30	70	100

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.SC. MATHEMATICS (SEMESTER II)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BMTC-201	Differential Equations	06	30	70	100
	Total	06	30	70	100

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.SC. MATHEMATICS (SEMESTER III)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BMTC-301	REAL ANALYSIS	06	30	70	100
BMTS-301 OR BMTS-302 OR BMTS-303	Logic and Sets or Analytical Geometry or Integral Calculus	04	30	70	100
	Total	10	60	140	200

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.SC. MATHEMATICS (SEMESTER IV)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BMTC-401	Algebra	06	30	70	100
BMTS-401 OR BMTS-402 OR BMTS-403	Vector Calculus or Theory of Equation or Number Theory	04	30	70	100
	Total	10	60	140	200

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.SC. MATHEMATICS (SEMESTER V)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BMTD-501 OR BMTD-502 OR BMTD-503	Matrices or Mechanics or Linear Algebra	06	30	70	100
BMTS-501 OR BMTS-502 OR- BMTS-503	Probability and Statistics or Mathematical Finance or Mathematical Modeling	04	30	70	100
	Total	10	60	140	200

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

B.SC. MATHEMATICS (SEMESTER VI)

Course Code	Course Title	Credit	Marks for		Total Marks
			IA*	EE**	
BMTD-601 OR BMTD-602 OR BMTD-603	Numerical Methods or Complex Analysis or Linear Programming	06	30	70	100
BMTS-601 OR BMTS-602 OR BMTS-603	Boolean Algebra or Transportation and Game Theory or Graph Gheory	04	30	70	100
	total	10	60	140	200

*INTERNAL ASSESSMENT **EXTERNAL EXAMINATION

SEMESTER I

BMTC-101- DIFFERENTIAL CALCULUS

Total Hours-60

Credits-06

Unit-1

Limit and Continuity (ϵ and δ definition), Types of discontinuities, Differentiability of functions.

Unit-2

Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions, Tangents and normals.

Unit-3

Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

Unit-4

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $\sin x$, $\cos x$, e^x , $\log(1+x)$, $(1+x)^m$, Maxima and Minima, Indeterminate forms.

Books Recommended

1. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2011.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.
3. Ganesh Prasad, *A textbook for differential calculus*, London Green & co.
4. Shanti Narayan, *Differential Calculus*, S.Chand & co.

SEMESTER II

BMTC-201-DIFFERENTIAL EQUATION

Total hours-60

Credit-06

Unit-1

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

Unit-2

First order higher degree equations solvable for x , y , p . Methods for solving higher-order differential equations, Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.

Unit-3

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

Unit-4

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

Books Recommended -

1. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, International Edition, 1967.
3. Schaum's, Outlines of Differential Equations, McGraw-Hill, International Education Pvt Ltd.

SEMESTER III BMTC-301 REAL ANALYSIS

Total hours-60

Credit-06

Unit-1

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of \mathbb{R} , Archimedean property of \mathbb{R} , intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Unit-2

Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Unit-3

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series,

Unit-4

Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence. Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M-test.

Books Recommended -

1. T. M. Apostol, Calculus (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, Introduction to Real Analysis, John Wiley and Sons 7 (Asia) P. Ltd., 2000.
3. K.A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer Verlag, 2003.
4. S.C. Malik & Savita Arora, Mathematical Analysis, New age international publisher.

BMTS-301-LOGIC AND SETS

Total hours- 60

Credit-04

Unit-1

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

Unit-2

Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Unit-3

Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Unit-4

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Book Recommended -

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

BMTS-302- ANALYTICAL GEOMETRY

Total hours-60

Credit-04

Unit-1

Introduction of parabola, techniques for sketching parabola.

Unit-2

Ellipse and hyperbola, Reflection properties of parabola, ellipse and hyperbola, Classification of quadratic equations representing lines

Unit-3

Sphere, Cone, Cylindrical Surfaces, Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid. Central Conicoids.

Book Recommended-

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd., 2002.
3. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

BMTS-303-INTEGRAL CALCULUS

Total Hours-60

Credit-04

Unit-1

Integration by Partial fractions, integration of rational and irrational functions.

Unit-2

Properties of definite integrals. Reduction formulae for integrals of rational

Unit-3

Trigonometric, exponential and logarithmic functions and of their combinations.

Unit-4

Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. Double and Triple integrals.

Books Recommended -

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd., 2002.

SEMESTER IV BMTC-401-ALGEBRA

Total hours-60**Credit-06****Unit-1**

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group $U(n)$ of units under multiplication modulo n . Cyclic groups from number systems, complex roots of unity, circle group,

Unit-2

The general linear group $GL_n(n, R)$, groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group $Sym(n)$, Group of quaternions, Subgroups, cyclic subgroups,

Unit-3

The concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Unit-4

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n , ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Z_p , Q , R , and C .

Books Recommended -

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.
4. George E Andrews, Number Theory, Hindustan Publishing Corporation, 1984.

BMTS-401-VECTOR CALCULUS

Total Hours-60

Credit-04

Unit-1

Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors.

Unit-2

Gradient, divergence and curl.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

BMTS-402 THEORY OF EQUATIONS

Total Hours-60

Credit-04

Unit-1

General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials,

Unit-2

General properties of equations, Descarte 's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

Unit-3

Symmetric functions, Applications symmetric function of the roots, Transformation of equations.

Unit-4

Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

Books Recommended -

1. W.S. Burnside and A.W. Panton, The Theory of Equations, Dublin University Press, 1954.
2. C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc., 1954.

BMTS-403- NUMBER THEORY

Total Hours-60

Credit-04

Unit-1

Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem.

Unit-2

Goldbach conjecture, binary and decimal representation of integers, linear congruences, complete set of residues.

Unit-3

Number theoretic functions, sum and number of divisors, totally multiplicative functions.

Unit-4

Properties of the Dirichlet product, the Möbius inversion formula, the greatest integer function, Euler's phi-function.

Books Recommended-

1. David M. Burton, Elementary Number Theory 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, Applications of Abstract Algebra with Maple, CRC Press, Boca Raton, 2000.
3. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

SEMESTER V

BMTD-501-MATRICES

Total hours-60

Credit-06

Unit-1

R, R², R³ as vector spaces over R. Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R², R³.

Unit-2

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

Unit-3

Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four.

Unit-4

Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices.

Books Recommended-

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of 17 India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, *Theory and Problems of Matrix Operations*, Tata McGraw Hill, 1989.

BMTD-502-MECANICS

Total Hours-60

Credit-06

Unit-1

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body.

Unit-2

Laws of friction, Problems of equilibrium under forces including friction.

Unit-3

Centre of gravity, Work and potential energy. Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve).

Unit-4

Simple harmonic motion, Simple Pendulum.

Books Recommended-

1. A.S. Ramsay, Statics, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, Statics and Dynamics with Background in Mathematics, Cambridge University Press, 2003.

BMTD-503 -LINEAR ALGEBRA

Total Hours-60

Credit-06

Unit-1

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Unit-2

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation.

Unit-3

Algebra of linear transformations. Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.

Unit-4

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books Recommended-

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education 20 Asia, IndianReprint, 2007.
3. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
4. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
5. Schaum's, Linear Algebra, McGraw-Hill, International Education Pvt Ltd.

BMTS-501- PROBABILITY AND STATISTICS

Total Hours-60

Credit-04

Unit-1

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation,

Unit-2

Moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential.

Unit-3

Joint cumulative distribution function and its properties, joint probability density functions.

Unit-4

Marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

Books Recommended-

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Application*, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Model*, 9th Ed., Academic Press, Indian Reprint, 2007.

BMTS-502- MATHEMATICAL FINANCE

Total Hours-60

Credit-04

Unit-1

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money.

Unit-2

Inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields. Floating-rate bonds, immunization.

Unit-3

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation)

Unit-4

Random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set.

Books Recommended-

1. David G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998.
2. John C. Hull, Options, Futures and Other Derivatives, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
3. Sheldon Ross, An Elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA, 2003.

BMTS-503- MATHEMATICAL MODELING

Total Hours-60

Credit-04

Unit-1

Applications of differential equations: the vibrations of a mass on a spring, mixture problem.

Unit-2

Free damped motion, forced motion, resonance phenomena, electric circuit problem, mechanics of simultaneous differential equations.

Unit-3

Applications to Traffic Flow. Vibrating string, vibrating membrane.

Unit-4

Conduction of heat in solids, gravitational potential, conservation laws.

Books Recommended-

1. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, International Edition, 1967.

SEMESTER VI

BMTD-601-NUMERICAL METHODS

Total hours-60

Credit-06

Unit-1

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method.

Unit-2

Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods.

Unit-3

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

Unit-4

Numerical differentiation: forward difference, backward difference and central Difference. Integration: trapezoidal rule, Simpson's rule, Euler's method.

Recommended Books-

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

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007

BMTD-602 COMPLEX ANALYSIS

Total Hours-60

Credit-06

Unit-1

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas,

Unit-2

Cauchy-Riemann equations, sufficient conditions for differentiability. Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions,

Unit-3

Definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

Unit-4

Liouville's theorem and Taylor and Laurent series, and its examples.

Books Recommended-

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, Complex analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

BMTD-603- LINEAR PROGRAMMING

Total Hours-60

Credit-04

Unit-1

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes.

Unit-2

Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.

Unit-3

Introduction to artificial variables, two-phase method, Big-M method and their comparison.

Unit-4

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

Recommended Books-

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.

BMTS-601 BOOLEAN ALGEBRA

Total Hours-60

Credit-04

Unit-1

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements.

Unit-2

Lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms.

Unit-3

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials.

Unit-4

Minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Books Recommended:

1. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

BMTS-602-TRANSPORTATION AND GAME THEORY

Total Hours-60

Credit-04

Unit-1

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution.

Unit-2

Algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit-3

Game theory: formulation of two person zero sum games, solving two person zero sum games

Unit-4

Games with mixed strategies, graphical solution procedure.

Books Recommended:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F. S. Hillier and G. J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.

BMTS-601-GRAPH THEORY

Total Hours-60

Credit-04

Unit-1

Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits.

Unit-2

Eulerian circuits, Hamiltonian cycles, the adjacency matrix.

Unit-3

Weighted graph, travelling salesman's problem.

Unit-4

Shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.
2. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian Sreprint, 2004.

