Central University of Bihar
School of Education
BSc.BEd (Four Years Integrated Programme)
List of Courses for BSc.BEd Programme in Mathematics (40 Credits)

Course Code	Course Title	Credits
	Semester - I	
MTH 101	Introductory Mathematics	4
	Semester – II	
MTH 151	Analysis I	4
	Semester – III	
MTH 201	Linear Algebra and ODE	4
	Semester – IV	
MTH 251	Analysis II	4
	Semester – V	
MTH 301	Algebra 1	3
MTH 302	Differential Equations	3
	Total Credits	**6**
	Semester – VI	
MTH 351	Analysis III	3
MTH 352	Coordinate Geometry and Complex Analysis	3
	Total Credits	**6**
	Semester – VII	
MTH 401	Algebra II	3
MTH 402	Programming in C with Numerical Methods	3
	Total Credits	**6**
	Semester – VIII	
MTH 451	Probability and Statistics	3
MTH ***	Elective - I	3
	Total Credits	**6**
List of Electives		
MTH 452	Linear Programing	3
MTH 453	Discrete Mathematics	3
MTH 554	Graph Theory	3
MTH 455	Number Theory	3
MTH 456	Statistics and Dynamics	3
MTH 457	Mechanics	3

Annexure I

Course Structure and Syllabus for the Courses of Mathematics in B.Sc. – B.Ed. dual degree programme

Semester I

Introductory Mathematics (4 credits) (3 theory+1 tutorial)

Unit I Sets, relation, Functions, domain, codomain and range of a function, graph of functions, injection, surjection and bijection, composition of functions, Countability, The algebraic and order properties of R, suprema and infima, the completeness property of R, the Archimedean property, density of rational numbers in R, characterization of intervals, neighbourhoods, open sets, closed sets, limit points of a set, isolated points, closure, complements, Cantor intersection theorem for nested intervals, Cardinal arithmetic, Schroeder-Bernstein Theorem, Equivalence relation, partial order relation, Maximal and minimal elements.

Unit II Divisibility, The Division Algorithm, The greatest common divisors, The Euclidean algorithm, Linear Diophantine equations, Primes and their distribution, The fundamental theorem of arithmetic, Congruence, The Chinese remainder theorem, Fermat Little theorem, Wilson theorem, Euler's Phi- function, Number theoretic functions.

Unit III Systems of linear equations, Equivalent systems, Elementary row operations, the elimination methods, augmented matrix, Echelon form, Reduced Echelon form, Solutions to linear systems, Homogeneous systems of linear equations, Matrices, Matrix operations, Matrix Multiplication, Inverse of a square Matrix, Elementary Matrices, Determinants, Properties of Determinant, Cramer's Rule.

Texts/References

1. K. K. Jha, *Advanced Set Theory, Axiomatic Set Theory and Boolean Algebra*, Navbharat Publishing House, Patna.
2. R. G. Bartle and D. R. Sherbert**,** *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Sigapore, 2002.
3. John M. Howie, Real Analysis, SUMS, 2001.
4. S. C. Malik, *Principles of Real Analysis*, Revised Edition, New Age International, New Delhi, 2000.
5. David M. Burton, *Elementary Number Theory*, McGraw - Hill Higher Education, 2007.
6. K. Hoffman and R. A. Kunze, *Linear Algebra*, 3rd edition, Prentice Hall, 2002.
7. Promode Kumar Saikia, *Linear Algebra*, Pearson Education, 2009.

Semester II

Analysis I (4 credits) (3 theory+1 tutorial)

Unit I: Sequences, limit of a sequence, convergent sequences, limit theorems, monotone sequences, monotone convergence theorem, subsequences, convergence and divergence criteria, existence of monotonic subsequences, Bolzano-Weierstrass theorem for sequences and sets, definition of Cauchy sequence, Cauchy's convergence criterion, limit superior and limit inferior of a sequence.

Unit II Definition of infinite series, sequence of partial sums, convergence of infinite series, Cauchy criterion, absolute and conditional convergence, convergence via boundedness of sequence of partial sums, tests of convergence: comparison test, limit comparison test, ratio test, Cauchy's nth root test (proof based on limit superior), integral test (without proof), alternating series, Leibniz test, Arbitrary term series, rearrangements of series, Limits of functions of a real variable, Continuity of functions, Basic properties of continuous functions, Uniform continuity.

Unit III Differentiability, Successive differentiation, Leibnitz theorem, Asymtotes, curvature, envelope, concavity and convexity, Tracing of curves in Cartesian and polar coordinates, Caratheodory theorem, chain rule, derivative of inverse functions, intermediate value property for derivatives (Darboux'stheorem), Rolle's theorem, Mean value theorem, Cauchy's mean value theorem, Power series, radius of convergence, Taylor series, Maclaurin series, L'Hˆopital's Rule.

Texts/References

1. R. G. Bartle and D. R. Sherbert**,** *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Sigapore, 2002.
2. K. A. Ross, *Elementary Analysis: The Theory of Calculus*, Undergraduate Text in Mathematics, Springer (SIE), Indian reprint, 2004.
3. Sudhir R. Ghorpade, Balmohan V. Limaye, *A Course in Calculas and Real Analysis*, Springer (UTM), New York, 2006.
4. John M. Howie, *Real Analysis*, SUMS, 2001.
5. Franf Morgan, *Real Analysis*, AMS, Indian Edition, 2010.
6. Tom M. Apostel. Mathematical Analysis, Narosa Publications, NewDelhi, 2002.
7. Walter Rudin, *Principles of Mathematical Analysis*, McGraw-Hill International Editions, 1976.
8. S.C.Malik, Principles of Real Analysis, Revised Edition, New Age International, New Delhi, 2000.
9. M. J. Strauss**,** G. L. Bradley and K. J. Smith, *Calculus* (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
10. H. Anton**,** I. Bivens and S. Davis**,** *Calculas* (7th Edition), John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2002, dersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.

Semester III

Linear Algebra and ODE (4 credits) (3 theory+1 tutorial)

Unit I Vector Spaces and examples, Subspace, Special example of Rn and its coordinates, Sum and intersection of subspaces, Solution space of linear equations, Linear independence of vectors, Basis and Dimension, Coordinates with respect to different basis. Linear Transformation between two vector spaces, representing Linear Transformation by a Matrix, Rank-Nullity Theorem, Linear Operators and square Matrices, Algebra of Linear operators, Base change and similarity of matrices.

Unit II Eigen value and Eigen vector, Characteristic polynomials, Diagonalisation and Triangulation of Matrices, Cayley Hamilton Theorem, Minimal Polynomial of a Matrix, Inner Product Spaces, Cauchy- Schwartz Inequality, Orthogonal basis, Grahm orthogonalisation process.

Unit III Order and degree of ODE, Solution of first order ODE, first-order differential equations of higher degree, solvable for p, solvable for y, solvable for x, Clairaut's form, application of first-order differential equations, Higher order Differential equation, homogeneous and non-homogeneous equation, Reduction of order, solution of Linear equation with constant coefficients, method of undetermined coefficients, method of variation of parameters.

Texts/References

1. K. Hoffman and R. A. Kunze, *Linear Algebra*, 3rd edition, Prentice Hall, 2002.
2. S. Lang, *Introduction to Linear Algebra*, 3nd Edition, Addition-Wesley, 1999.
3. Sheldon Axler, Linear Algebra Done right, Springer UTM, 1997.
4. David Poole, Linear Algebra: A Modern Introduction, Thomson Brooks/cole, 2006.
5. G. Strang, *Linear Algebra and its Applications*, Thomas Brooks/Cole, 2006.
6. Paul R. Halmos, *Linear Algebra Problem Book*, Dolciani Mathematical Expositions, The Mathematical Association of America.
7. Earl A. Coddington, *An Introduction to Ordinary Differential Equations*, New Delhi PHI 2010
8. M. D. Rai Singhania, Advanced Differential Equation, S. Chand 2009.

Semester IV

Analysis II (4 credits) (3 theory+1 tutorial)

Unit I Integration and its application to length, area, volume and surface area of revolution, centroids and quadrature rules, Riemann Integral, Integrability of continuous and monotonic functions, Fundamental theorems of integral calculus, Mean Value theorems of integral calculus

Unit II: Introduction to function of several variables, neighbourhood of a point in R^2 , Limit of function of several variables, continuity of function of several variables, partial derivatives, Gradient, Directional derivatives, Tangent planes and normal lines, Jacobian, Differentiability of function of two variables, Extreme values of functions of several variables, Necessary and Sufficient conditions for extreme values.

Unit III: Multiple integrals, Existence and Properties of integrals, iterated integrals, change of variables, Parametric equations, Cylindrical, Spherical and polar coordinates, Divergence, Curl, Laplacian in Cartesian, cylindrical and spherical coordinates, Vector Fields, line integrals, The Fundamental Theorem for line integrals, Green's theorem, Parametric surfaces and their areas, surface integrals, volume integrals, Green, Stoke's and Gauss's divergence theorem.

Texts/References

1. J. Stewart, *Calculus with Early Transcendental Functions*, Cengage Learning.
2. M. J. Strauss**,** G. L. Bradley and K. J. Smith, *Calculus* (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. T.M. Apostol, *Mathematical Analysis*, 5th edition, Addison-Wesley; Publishing Company, 2001.
4. T. M. Apostol, *Calculus-II*, 2nd edition, John Wiley & Sons, 2003.
5. W. Rudin, *Principles of Mathematical Analysis*, 5th edition, McGraw Hill Kogakusha Ltd., 2004.
6. R. G. Bartle, *The elements of Real Analysis*, 2nd edition, John Wiley & Sons, Inc., New York, 1976.
7. Sudhir R. Ghorpade, Balmohan V. Limaye, *A Course in Multivariable Calculus and Analysis*, Springer International Edition, 2010.
8. Sean Dineen, *Multivariate Calculus and Geometry*, SUMS, 2001.
9. H. M. Schey, Div grad curl and all that, W. W. Noorton and Company, New York, London.

Semester V

Algebra I (3 credits) (2 theory+1 tutorial)

Unit I Symmetry of square, dihedral groups, Matrix Groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups, subgroups and example of subgroups, centralizer, center of a group, cyclic group, classification of subgroups of cyclic groups, Cycle notation for permutation, properties of permutations, even and odd permutation, a check-digit scheme based on the dihedral group D5, Product of two subgroups, definition and properties of cosets, Lagranges theorem and its consequences including Fermat's Little theorem, an application of cosets to permutation groups, the rotation group of a cube and a soccer ball.

Unit II External direct product of groups, normal subgroup, factor groups, homomorphisms, isomoprphisms and automorphisms of groups, automorphism group of finite and infinite cyclic groups, Cauchy's theorem for finite abelian groups, conjugacy, actions, orbits, stabilizers, counting orbits, Finite rotation groups, The Euclidean Groups.

Texts/References

1. J. A. Gallian, *Contemporary Abstract Algebra*, 7th Edition, Cengage Learning, 2010.
2. M. A. Armstrong, *Groups and Symmetry*, Springer.
3. M. Artin, Algebra, Prentice Hall of India, 1994.
4. D.S. Dummit and R.M. Foote, *Abstract Algebra*, John Wiley & Sons, 2003.
5. I. N. Herstein, *Topics in Algebra*, 4th Edition, Wiley Eastern Limited, New Delhi, 2003.

Differential Equations (3 credits) (2 theory+1 tutorial)

Unit I Power series solutions of linear Differential equations about ordinary point and singular point, the method of Frobenius, Bessel's equation, Legendre's equation, properties of Bessel's and Legendre's functions, Matrices and Linear systems, Matrix Exponential, Homogeneous systems: Distinct and repeated real Eigen values, complex eigen value, Method of variation of parameters, Laplace transforms and its applications to PDE.

Unit II Basic concepts and definition of Partial differential equation, Classification of partial differential equation, solution of first order partial differential equation, solution of linear partial differential equation with constant coefficient, Monge's method for a special class of Non-Linear Equations (Quasilinear Equation) of the second order.

Texts/References

1. Earl A. Coddington, *An Introduction to Ordinary Differential Equations*, New Delhi PHI 2010.

2. S. L. Ross, *Differential Equations*, 3rd Edn., Wiley India, 1984.
3. George F. Simmons, *Differential Equations with Applications and Historical Notes*, TMH.
4. T. Amaranath, *An elementary course in partial differential equation*, Narosa publication 2009.
5. A H Siddiqi, P Manchanda, *A first course in Differential Equations with Application*, Macmillan publishers, 2009.
6. J. L. Schiff, *The Laplace Transform: Theory and Applications*, UTM, Springer, 1991.

Semester VI

Analysis III (3 credits) (2 theory+1 tutorial)

Unit I: Improper integrals and their convergence, Comparison test, Abel's and Dirichlet's test, Integral as a function of a parameter and its applications, Beta and Gamma functions and their relations.

Series of functions, Weierstrass M-test, Weierstrass approximation theorem (statement only), Point wise and uniform convergence of sequence of functions, uniform convergence and continuity, uniform convergence and differentiation, Uniform convergence and integration, Fourier series.

Unit II: Metric spaces: Definition and examples of metric spaces, isometries, diameter, isolated points, accumulation and boundary points, closure and interior, open and closed sets, Cantor's intersection theorem, open and closed balls, convergence, Cauchy sequence and boundedness, Continuity and uniform continuity, completeness, contraction mapping theorem.

Texts/References

1. R. G. Bartle and D. R. Sherbert**,** *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Sigapore, 2002.
2. Tom M. Apostel, *Mathematical Analysis*, Narosa Publications, NewDelhi, 2002.
3. Walter Rudin, *Principles of Mathematical Analysis*, McGraw-Hill International Editions, 1976.
4. S. C. Malik, Savita Arora, *Principles of Real Analysis*, Revised Edition, New Age International, New Delhi, 2000.
5. S. Kumarsan, *Topology of Metric Spaces* 2nd Edition, Narosa Publications, NewDelhi,

Coordinate Geometry and Complex Analysis (3 credits) (2 theory +1 tutorial)

Unit I Line and plane, Shortest distance, Equation of sphere, Tangent plane, Intersection of two spheres, Radical plane Coaxial spheres, Conjugate systems, Equation of cone, Intersection of Cone with plane and a line, Cone and Cylinder, Enveloping and right circular cylinders, Equations of central conicoids, Plane of contact and polar plane, Enveloping cone and enveloping cylinder, Conjugate diameters and diameters planes, Equations of paraboloids and its simple properties.

Unit II Complex Numbers, Stereographic Projection, Elementary Functions, Limits, Continuity of complex functions, Differentiable functions, Analytic and Harmonic Functions, The Cauchy-Riemann Equations, Complex line Integration, Cauchy;s theorem using Green's Theorem, Cauchy's Integral formula.

Texts/References

1. R. J. T. Bell, Elementary Treatise on Co-ordinate Geometry of Three Dimensions, Machmillan India Ltd., 1994.

2. P. K. Jain and Khalil Ahmad, Analytical Geometry of Three Dimensions, New Age, International (P) Ltd., New Delhi, 1991.

3. Theodore W. Gamelin, Complex Analysis, *Springer, UTM, 2001*.

4. John H. Mathews, Russel W. Howel, Complex Analysis for Mathematics and Engineering, *Jones and Bartlett Publishers.*

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

Semester VII

Algebra II (3 credits) (2 theory+1 tutorial)

Unit I Definition and examples of rings, properties of rings, subrings, integral domains, definition and examples of fields, characteristic of rings, ideals, ideal generated by subsets in a commutative ring with unity, factor rings, prime ideals, maximal ideals, homomorphisms and isomorphisms of rings, Polynomial rings over commutative rings, the division algorithm and consequences, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[X], an application of unique factorization to weird dice.

Unit II Fundamental theorem of Algebra (statement only), roots and their multiplicity, Relationship between roots and the coefficients, Fundamental theorem of symmetric polynomial (without proof), Evaluation of symmetric functions of roots, rational roots of polynomials with integral coefficients, Descartes rule of sign, Strum's theorem (statement only), Solution of cubic equation, Cardon's method and solution of bi-quadratic equation, Field extensions, Kronecker's Theorem, construction of finite fields.

Texts/References

1. J. A. Gallian, *Contemporary Abstract Algebra*, 7th Edition, Cengage Learning, 2010.
2. D.S. Dummit and R.M. Foote, *Abstract Algebra*, John Wiley & Sons, 2003.
3. M. Artin, *Algebra*, Prentice Hall of India, 1994.
4. I. N. Herstein, *Topics in Algebra*, 4th Edition, Wiley Eastern Limited, New Delhi, 2003.
5. Mapa, S. K., *Higher Algebra*, (Asoke Prakashan, Calcutta, 2006)

Programing in C with Numerical Methods (3 credits) (2 theory+1 tutorial)

Unit I Structure of a C Program: basic data types, enumerated data types, derived data types, local, global, parametric variables, assignment of variables; numeric, character, real and string constants, Arithmetic, Relation and logical operators, Assignment operators, Increment and Decrement operators, conditional operators, Type modifiers and expressions, Writing and interpreting expressions, using expressions in statements, Basic input/output. Control Statements, conditional statements, if...else, nesting of if....else, else if ladder, switch statements, Loops in C: for, while, do... while loops, Break, Continue, exit( ), goto and label declarations, arrays, Functions definition and declaration.

Unit II Errors, Convergence, Bisection Method, Regula-Falsi Method, Fixed point iteration method, Matrix Computation, factorial, Newton's method, Secant method, finite difference operator, forward differences, backward difference and central difference, Lagrange and newton interpolation, Numerical differentiation, Integration, trapezoidal rule, Simpson's rule.

Lab [C programme based on Numerical Method].

Texts/References

1. M. K. Jain, S. R. K. Iyengar and R.K. Jain, *Numerical methods for Scientific and Engineering Computation*, New age International Publisher, India, 2007.
2. Brian W. Kernighan, Dennis M. Ritchie, *The C Programming Language*, 2nd Edition, Prentice Hall, PTR.
3. E. Balagurusawy, *Programming in ANSI C*, the Mc Graw-Hill companies 2009.
4. D. Prasad, *An Introduction to Numerical Analysis*, 3rd Edition Narosa Publishing house 2011.
5. S. Balachandra Rao, H.R. Anuradha, *Differential Equation with Application and Programs*, Hyderabad University press 1996.

6. S. S. Sastry, *Introduction to Numerical Analysis*, Prentice Hall.

Semester VIII

Probability and Statistics (3 credits) (2 theory+1 tutorial)

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

Unit II Joint probability density functions, marginal and conditional distributions, Joint cumulative distribution function and its properties, expectation of functions of two random variables, conditional expectations, independent random variables, bivariate normal distribution, joint moment generating function, correlation, regression, Central limit theorem, Chebyshev's inequality.

Texts/References

1. Robert V. Hogg, Joseph W. McKean and T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, *John E. Freud's Mathematical Statistics with Applications*, Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models, Academic Press, Indian Reprint, 2007.
4. Alexander McFarlane Mood, Franklin A. Graybill, *Introduction to the Theory of Statistics*, TMH.

Elective (3 credits) (2 theory+1 tutorial)

List of Electives

1. Linear Programing
2. Discrete mathematics
3. Graph Theory
4. Number Theory
5. Statics and Dynamics
6. Mechanics