Scheme for Choice Based Credit System (CBCS)

B.A/B.Sc. Applied Mathematics

From Year 2016 and onwards

Semester	Name of the course	Course No.	Nature of course	Credits
1	Calculus	BAMM-CR-16101	Core	6
2	Differential Equations	BAMM-CR-16201	Core	6
3	Real Analysis	BAMM-CR-16301	Core	6
	Complex Trigonometry , Logic and Sets	BAMM-SEC-16301	SEC	4
4	Algebra	BAMM-CR-16401	Core	6
	Theory of Equations and Linear Programming	BAMM-SEC-16401	SEC	4
5	Methods of Applied Mathematics-I	BAMM-DSE-16501	DSE	6
	Mechanics	BAMM-DSE-16502	DSE	6
	Advanced Calculus and Mathematics Finance	BAMM-SEC-16501	SEC	4
6	Methods of Applied Mathematics-II	BAMM-DSE-16601	DSE	6
	Laplace and Fourier Transformations	BAMM-DSE-16602	DSE	6
	Mathematical Modeling, Transportation and Game Theory	BAMM-SEC-16601	SEC	4

Note: The students have to opt one course from SEC in each of the semester III, IV, V & VI.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester - I

Course Name: Calculus (6 credits)
Course No: BAMM-CR-16101

Unit-I

Limit and Continuity ($\in$ and δ definition), types of discontinuities, properties of continuous functions on closed intervals, differentiability of functions, Successive differentiation, Leibnitz's theorem, partial differentiation, total differentials, Euler's theorem on homogenous functions.

Unit-II

Tangents and normals (polar coordinates only), pedal equations, curvature and radius of curvature, asymptotes, singular points, tracing of curves in cartesian and polar coordinates.

Unit-III

Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's 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.

Unit-IV

Integration by partial fractions, integration of rational and irrational functions, definite integrals and their properties, reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations.

Books recommended

1. G.B. Thomas and R. L. Finney, *Calculus*, Pearson Education, 2007.
2. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
3. S. D. Chopra, M. L. Kochar and A.Aziz, *Differential Calculus*, Kapoor Publications.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester - II

Course Name: Differential Equations (6 credits)
Course No: BAMM-CR-16201

Unit-I

Differential equations, integrating factors, Bernoulli's equation, exact differential equations, necessary and sufficient conditions for exactness, symbolic operators, homogeneous and non-homogeneous linear differential equations with constant coefficients and those reducible to such equations.

Unit-II

Miscellaneous forms of differential equations, first order higher degree equations solvable for X, Y, Z, P equations from which one variable is explicitly absent, Clairut's form, equations reducible to Clairut's form.

Unit-III

Legendre polynomials, Bessel function, recurrence relation and differential equation satisfied by each of these functions, Wronskian and its properties

Unit-IV

Formation of partial differential equations, order and degree of partial differential equations, concept of linear and non-linear partial differential equations, linear partial differential equation of first order, Lagrange's method, Geometrical interpretation of the form Pp + Qq = R, Charpit's method, classification of second order partial differential equations into elliptical, parabolic and hyperbolic through illustrations only.

Books recommended

1. I.Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.
2. M. D. Raisinghania, *Ordinary differential Equations.*
3. S. D. Chopra and M.L.Kochar, *Integral Calculus*, Kapoor Pub.
4. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Willey and Sons, 1984.
5. Schaun Series, *Differential Equations*.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -III

Course Name :Real Analysis (6 credits)
Course No: BAMM-CR-16301

Unit-I

Finite and infinite sets, examples of countable and uncountable sets, real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals, concept of cluster points and statement of Bolzano-Weierstrass theorem.

Unit-I

Real sequence, bounded sequence, Cauchy convergence criterion of sequences, Cauchy's theorem on limits, order preservation and seqeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Unit-I

Infinite series, Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, alternating series, Leibnitz's test, definition and examples of absolute, conditional and uniform convergence.

Unit-IV

Sequences and series of functions point wise and uniform convergence, Mn-test, M-test, statements of the results about uniform convergence and integrability and differentiability of functions, power series and radius of convergence.

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 (Asia) P. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis,* Springer Verlag, 1983.
4. K.A.Ross, *Elementary Analysis – The Theory of Calculus Series*- Undergraduate Texts in Mathematics, Springer Verlag 2003.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -III

Course Name: Complex Trigonometry, Logic and Sets (4 credits)

Course o: BAMM-SEC-16301

Unit-I

Review of complex number system, triangle inequality, equation of a circle and ellipse in complex form, De Moivere's theorem and its applications, expansion of sin nθ, cos nθ etc. in terms of powers of sin θ, cos θ and expansion of $\sin^n \theta$ and $\text{sos}^n \theta$ in terms of multiples of θ.

Unit-II

Functions of a complex variable, exponential, circular, hyperbolic, inverse hyperbolic and logarithmic functions of a complex variable and their properties, summation of trigonometric series, difference method, C + iS method, C-R equations, definition of analytic functions.

Unit-III

Introduction, propositons, truth table, negation, conjuction and disjunction. Implications biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators, propositional equivalence, logical equivalences, predicates and quantifiers, introduction, Quantifiers, Binding variables and negations. 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-IV

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.

Text Books Recommended

1. S.D. Chopra and M.L. Kochar and A.Aziz-ul-Auzeem, Differential Calculus (Thoroughly revised and enlarged new edition- 2004).
2. A.Aziz and N.A.Rather, Complex Trigonometry, KBS.
4. R.P.Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
5. P.R.Halmos, Native Set Theory, Springer, 1974.
6. E.Kamke, Theory of Sets, Dover Publishers, 1950.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -IV

Course Name: Algebra (6 credits)
Course No: BAMM-CR-16401

Unit-I

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

Unit-II

Subgroups, cyclic subgroups, 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,

Unit-III

Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Unit-IV

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 quanternions, rings of matrices, polynomial rings, and rings of continuous functions, subrings and ideals, integral domain and fields, examples of fields: Z_p Q, R and C. Field of rational functions.

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 Andrew, *Number Theory*, Hindustan Publishing Corporation, 1984.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -IV

Course Name: Theory of Equations and Linear Programming (4 credits)

Course No: BAMM-SEC-16401

Unit-I

General properties of polynomials, graphical representation of polynomials, maximum and minimum values of polynomials, general properties of equation, Descarte's rule of signs positive and negative rule, relation between the roots and the coefficients of equations.

Unit-II

Symmetric functions, applications symmetric function of the roots, transformation of equations, solutions of reciprocal and binomial equations, algebraic solutions of the cubic biquadratic, properties of the derived functions

Unit-III

Linear programming problems, Graphical approach for solving some linear programs, convex sets, supporting and separating hyperplanes, theory of simplex method, optimally and unboundness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, tow-phase method.

Unit-IV

Big-M method and their comparison, duality, formulation of the dual problems, primal-dualrelationships, economic interpretation of the dual, sensitivity analysis.

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 and Sons Inc., 1954.
3. Mokhtar S.Bazara John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flow*, 2nd Ed., John Wiley and Sons, India, 2004.
4. F.S.Hiller and G.J.Lieberman, *Introduction to Operation Research*, 8th Ed., Tata McGraw Hill, Singapore, 2004.
5. Hamdy A.Taha, *Operation Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -V

Course Name: Methods of Applied Mathematics-I (6 credits)
Course No: BAMM-DSE-16501

Unit-I **Plane Geometry**

Parabola, tangents and normals, pole and polar, parametric equations of a parabola, ellipse, tangents and normals, pole and polar, parametric equations of ellipse, diameters, conjugate diameters and their properties. Hyperbola, tangents and normals, equation of hyperbola referred to asymptotes as axes, rectangular and conjugate diameters and their properties, tracing of conics (Cartesian co-ordinates only), general second degree equation in x and y, conditions under which a general second degree equation represents a conic and determination of equation of the corresponding conic.

Unit-II **Solid Geometry**

Sphere, radical plane, coaxial system, cone, vertex, guiding curve, generator, equation of cone with vertex as origin or a given vertex and guiding curve, condition that the general equation of the second degree should represent a cone, necessary and sufficient conditions for a cone to have three mutually perpendicular generators, cylinder, equation of the cylinder whose generators intersect a given conic and are parallel to given line, enveloping cylinder of a sphere, types of conicoids.

Unit-III **Discrete Mathematics**

Introduction to graphs, paths and cycles, operations on graphs, bipartite graphs and Konig's Theorem, Euler graphs and Euler's Theorem, Konigsberg bridge problem, Hamiltonian graphs, degree sequences.Tress and their properties, centers in tress, binary and spanning trees, cut vertex and cut edge in graphs, incidence and adjacency matrix in graphs, directed graphs.

Unit-IV **Boolean Algebra**

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms. Definition, examples and properties of modular and distributive

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

Text Books Recommended

1. P. Balasubrahamanyam, K.G. Subramanian and G.R.Venkataraman, Coordinate Geometry of two and three Dimensions.

2. S.Pirzada and T.A.Chishti, Analytical Solid Geometry, Universities Press, Orient Blackswan, 2007.

3. Shanti Narayan, Analytical Solid Geometry.

4. B.A.Davey and H.A.Priestley, *Introduction to lattices and Order*, Cambridge University Press, Cambridge, 1990.

5. S.Pirzada, *An Introduction to Graph Theory*, Universities Press, Orient Blackswan, 2012.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -V

Course Name: Mechanics (6 credits)

Course No: BAMM-DSE-16502

Unit-I

Resultant forces, acting at a point, parallelogram law of forces, resultant of two forces, components of a force, Triangle law of forces, Lame's Theorem, Polygon law of forces, Theorem of resolved parts, resultant of a number of forces acting at a point, conditions for equilibrium of any number of forces acting on a particle, equilibrium of bodies resulting on a smooth inclined plane.

Unit-II

Parallel forces, resultant of two parallel forces, equilibrium of three parallel forces, moments, geometrical representations, Varignon's Theorem, resultant of a number of co-planer forces acting on a rigid body, centre of a number of parallel forces, moments of a force about a line couples, equilibrium of two couples, couples in parallel planes, resultant of a number of coplanar couple, resultant of a force and a couple, resultant of a system of a coplanar forces.

Unit-III

Velocity and Acceleration, motion in a straight line, motion with constant acceleration, Boolies falling vertically, Boolean projected vertically upward, space average and time average, Newton's Law of motion, motion of connected particles, motion with variable acceleration.

Unit-IV

Simple Harmonic motion of a particle attached to an electric string, motion on an inclined plane, equation of motion of a particle varying in a plane, motion of a projectile, range on an inclined plane.

Books recommended

1. S.R.Gupta, Elementary Analytical Dynamics of a Particle of Rigid bodies.
2. K.R.Chaudhary and D.R.Jain, Elements of Statistics.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -V

Course Name: Advanced Calculus and Mathematical Finance (4 credits)

Course No: BAMM-SEC-16501

Unit-I

Jacobians, Curve linear integrals, Green's theorem, Beta, Gamma functions and relation between them.

Unit-II

Multiple integrals, Integral over the plane areas in xy-plane, double integrals, evaluation, change of order of integration of two variables, double integrals in polar co-ordinates, integral over regions in xyz-space, triple integrals, evaluation, triple integrals in cylindrical and spherical polar co-ordinates.

Unit-III

Basic principles: comparison, arbitrage and risk aversion, interest (simple and compound, discrete and continuous), time value money, 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, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bounds.

Unit-IV

Asset return, short selling, portfolio return (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), two fund theorem, risk free assets, one fund theorem, capital market line, sharp index, capital asset pricing model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

Books recommended

3. T.M.Apostol, Mathematical Analysis.
4. S.C.Malik and Gupta, Mathematical Analysis.
5. S.M.Shana and Saxena, Real Analysis.
6. David G. Luenberger, *Investment Science, Oxford University*, Press Delhi, 1998.
7. John C.Hull, Options, *Futures and Other Derivatives*, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
8. Sheldon Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, 2003.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -VI

Course Name: Methods of Applied Mathematics-II (6 credits)
Course No: BAMM-DSE-16601

Unit-I **Matrix Theory-I**

Types of matrices, Inverse of a square matrix, reversal law and its generalization, trace of a matrix, matrix polynomials, characteristic equation, matrix polynomials, Cayley-Hamilton Theorem, rank of a matrix, invariance of rank matrix under elementary row and column transformations. Reduction of matrix to normal form, elementary matrices, equivalence of matrices, linear dependence and linear independence of row(column) vectors, conditions for columns of a matrix to be linearly dependent, matrix A has rank r iff it has r linearly independent columns, analogous results for rows.

Unit-II **Matrix Theory-II**

Linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four. Linear product of two vectors, orthogonal and unitary matrices, determination of orthogonal matrices, eigen values and eigen vectors and their determination.

Unit-III **Vector Calculus**

Parametric representation of curves and surfaces; limit, continuity and differentiability of vector functions, derivative of sum, dot product and cross product of two vectors, gradient of a scalar field and directional derivative, geometrical representation. Divergence of vector field, curl of vector field, physical interpretation of divergence and curl, line integrals and Green's Theorem, surface area and surface integrals, Divergence Theorem of Gauss, Stoke's Theorem.

Unit-IV **Numerical Methods**

Introduction to numerical methods, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Seidel and SOR iterative methods. Algorithms and Convergence of solution. Lagrange and Newton interpolation, linear and higher order, finite difference operators, numerical differentiation, Forward difference, backward difference and central difference. Integration: trapezoidal rule, Simpson's rule, Euler's method.

Text Books Recommended:

1. A.Aziz, N.A.Rather & B.A.Zargar, A Text Book of Matrices, KBD.
2. Shanti Narayan, A Text Book of Matrices.

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

4 M.K.Jain, S.R.K, Lyengar and R.K.Jain, *Numerical Methods for Scientific and Engineering Computatio*n, 5th Ed., New age International Publisher, India, 2007.

6. G.B.Thomas and R.L. Finney, calculus, 9th Ed., Pearson Education, Delhi, 2005.
7. H.Anton, I.Bivens and S.Davis, Calculus, John Wiley and Sons (Asia) P.Ltd.
8. P.C.Matheew's, Vector Calculus, Springer Verlag London Limited, 1998.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -VI

Course Name: Laplace and Fourier Transformations (6 credits)

Course No: BAMM-DSE-16602

UNIT -I

Laplace transform-definition, Laplace transform of some elementary functions, piecewise continuity, functions of exponential order, sufficient conditions for existence of Laplace transform, linearity property, first and second translation (shifting property), Laplace transform of derivatives, Laplace transform of integrals, periodic functions, initial and final value theorems and their generalizations, methods of finding Laplace transform, differential equations, evaluation of integrals, the Gamma function, Bessel functions, the error function, sine and cosine integrals, exponential integral, unit step function, Dirac delta function, null functions, Laplace transform of special functions.

UNIT -II

Definition and uniqueness of inverse Laplace transform, Lerch's theorem, some inverse Laplace transform, some properties of Laplace transform, inverse Laplace transform of derivatives and integrals, the convolution property, methods of finding inverse Laplace transform, the complex inversion formula, the Heaviside expansion formula, the beta function, evaluation of integrals, ordinary differential equations with constant coefficients and with variable coefficients, simultaneous ordinary differential equations,

UNIT III

Introduction, periodic functions, Fourier series, Dirichlet's conditions, determination of Fourier coefficients, even and odd functions and their Fourier expansion, change of interval, half range series, simple applications of the transform to one dimensional problems, Harmonic analysis.

UNIT IV

Fourier transform, inverse Fourier transform, Fourier sine and cosine transforms and their inversion, properties of Fourier transforms, Fourier transform of the derivative, convolution theorem, discrete Fourier transform and fast Fourier transform and their properties, applications of Fourier transform in partial differential equations with special reference to heat and wave equation.

Recommended Books:

1. Murrey R. Spiegel, Laplace Transforms, Schaum's outline series.
2. I. N. Sneddon: The use of Integral Transforms, McGraw-Hill, Singapore 1972.
3. R. R. Goldberg, Fourier Transforms, Cambridge University Press, 1961.
4. D. Brain, Integral Transforms and their applications, Springer, 2002
5. L. Debnath and F. A. Shah, Wavelet Transforms and their applications, Springer, 2015.

Syllabus for B.A/B.Sc., Applied Mathematics, Semester -V

Course Name: Mathematical Modeling, Transportation and Game Theory (4 credits)

Course No: BAMM-SEC-16601

Unit-I

Introduction to mathematical modeling, types of modeling, classification of mathematical models, formulation, solution and interpretation of a model, linear growth and decay models, non-linear growth and decay models, continuous population models for single species, logistic growth model.

Unit-II

Fibonacci's rabbits, the golden ratio, compartment models, limitations of mathematical models. Applications of differential equations, Electric circuit problem, mechanics of simultaneous differential equations. conduction of heat in solids, gravitational potential, conservation laws.

Unit-III

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

Unit-IV

Game theory: formulation of two person zeros sum games, solving tow person zero sum games, games with mixed strategies, graphical solution procedure.

Books recommended

1. J.N. Kapur, Mathematical Modelling, Wiley Publishers.
2. M.A.Khanday, Introduction to Modeling and Biomathematics, Ariana Publishers, New Delhi.

3. Shepley L.Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
4. I.Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition.
5. Mokhtar S.Bazaraa, John J.Jarvis and Hanif D.Sherali, *Linear Programming and Network* Flows, 2nd Ed., John Wiley and Sons, India, 2004.
6. F.S.Hillier and G.J.Liebermann, *Introduction to Operation Research*, 9th Ed.,, Tata McGraw Hill, Singapore, 2009.
7. Hmady A.Taha, *Operation Research, An introduction*, 8th Ed., Prentice Hall India, 2006.