Syllabus

for

Bachelor of Science (Hons.) Applied Mathematics

Three Year Programme

Applicable from Session 2021-22

Department of Mathematics
Dev Sanskriti Vishwavidyalaya
Gayatrikunj-Shantikunj
Haridwar-249411 (Uttarakhand)

Proposed Syllabus, Regulations &
Scheme of Study for B.Sc. (Hons.) Applied Mathematics

Preface

Ministry of Human Resource Development (MHRD), Govt. of India, has already initiated the process for developing New Education Policy in our country to bring out reforms in Indian education system. University Grants Commission (UGC) participates more actively in developing National Education Policy, its execution and promotion of higher education in our country. UGC has initiated several steps to bring equity, efficiency and excellence in the higher education system of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching learning process, examination and evaluation systems, besides governance and other matters.

There are quite a large number of educational institutions, engaged in imparting education in our country. Majority of them have entered recently into semester system to match with international educational pattern.

Majority of Indian Higher Education Institutions have been following marks or percentage based evaluation system, which obstructs the flexibility for the students to study the subjects/courses of their choice and their mobility to different institutions. There is need to allow the flexibility in education system, so that students depending upon their interests and aims can choose interdisciplinary, intra-disciplinary and skill-based courses. This can only be possible when choice based credit system (CBCS), an internationally acknowledged system, is adopted.

The choice based credit system not only offers opportunities and avenues to learn core subjects but also exploring additional avenues of learning beyond the core subjects for holistic development of an individual. The CBCS will undoubtedly facilitate us bench mark our courses with best international academic practices. The CBCS has several advantages.

Advantages of the choice based credit system:

- Shift in focus from the teacher-centric to student-centric education.
- Student may undertake as many credits as they can cope with (without repeating all courses in a given semester if they fail in one / more courses).

- CBCS allows students to choose inter-disciplinary, intra-disciplinary courses, skill oriented papers (even from other disciplines according to their learning needs, interests and aptitude and more flexibility for students).
- CBCS makes education broad-based and at par with global standards. One can take credits by combining unique combinations. For example, Physics with Economics, Microbiology with Chemistry or Environment Science etc.
- CBCS offers flexibility for students to study at different times and at different institutions to complete one course (ease mobility of students). Credits earned at one institution can be transferred

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

Choice Based Credit System (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective / minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Framework of CBCS

- **Core (C) Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
- **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other

discipline/subject/ domain or nurtures the candidate's proficiency/skill is called an Elective Course.

- **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/ Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
- **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.
- **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called an Open Elective.
- **Ability Enhancement (AE) Courses:** The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SE).AECC courses are the courses based upon the content that leads to Knowledge enhancement of Environmental Science and English/MIL Communication. These are mandatory for all disciplines.SE courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

Regulations

A. **Eligibility for Admission:** Those candidates who have successfully completed 10 + 2 with 50% marks in Physics, Chemistry, Mathematics.

B. **Duration of Course:** This is a 3 years program split into 6 semesters each of duration 6 months.

C. **Attendance requirement, progress and conduct:** As per the existing norms of the Dev Sanskriti Vishwavidyalaya for other Bachelors' degree programme.

D. **Titles of papers / practical etc.:** Shown in tables.

E. **Scheme of Examination & Assessment:** Shown in tables.

Objectives: This course has been designed to provide a very good base for students who want to pursue their career or advance studies in Mathematics/Applied Mathematics field.

Bachelor of Science (Hons.) Applied Mathematics

Syllabus @ Glance

Papers Outline

Core Papers	14
Discipline Specific Electives	4
General Electives	4
Skill Enhancement Course	2
Ability Enhancement Course	2

Conventions

Core Papers	C
Discipline Specific Electives	DSE
General Electives	GE
Skill Enhancement Course	SE
Ability Enhancement Course	AE
Lecture	L
Practical	P
Tutorial	T

Course Structure and Semester Wise Distribution of Courses

Bachelor of Science (Hons.) Applied Mathematics, Semester I									
Course			**Instruction**			**Credits**	**Evaluation**		
			Hrs. per week				**External**	**Internal**	**Total**
Type	**Code**	**Title**	**L**	**T**	**P**				
C	BAM101	Calculus	5	1	-	6	60	40	100
C	BAM102	Algebra	5	1	-	6	60	40	100
GE	BAM103	GE1	5	1	-	6	60	40	100
AE		Environment Science	2	-	-	2	35	15	50
		Life Management	2	-	-	2	35	15	50
						22	Total Marks		400

Bachelor of Science (Hons.) Applied Mathematics, Semester II									
Course			**Instruction**			**Credits**	**Evaluation**		
			Hrs. per week				**External**	**Internal**	**Total**
Type	**Code**	**Title**	**L**	**T**	**P**				
C	BAM201	Real Analysis	5	1	-	6	60	40	100
C	BAM202	Differential Equations	5	1	-	6	60	40	100
GE	BAM203	GE2	5	1	-	6	60	40	100
AE		Professional Communication	2	-	-	2	35	15	50
		Life Management	2	-	-	2	35	15	50
						22	Total Marks		400

Bachelor of Science (Hons.) Applied Mathematics, Semester III									
Course			**Instruction**			**Credits**	**Evaluation**		
			Hrs. per week				**External**	**Internal**	**Total**
Type	**Code**	**Title**	**L**	**T**	**P**				
C	BAM 301	Theory of real functions	5	1	-	6	60	40	100
C	BAM 302	Abstract Algebra	5	1	-	6	60	40	100
C	BAM 303	Advanced Differential Equations	5	1	-	6	60	40	100
SE		As per University Options	2	-	-	2	35	15	50
GE	BAM 304	GE3	5	1	-	6	60	40	100
		Life Management	2			2	35	15	50
						28	Total Marks		500

Bachelor of Science (Hons.) Applied Mathematics , Semester IV									
Course			**Instruction**			**Credits**	**Evaluation**		
			Hrs. per week				**External**	**Internal**	**Total**
Type	**Code**	**Title**	**L**	**T**	**P**				
C	BAM 401	Numerical Methods	5	1	-	6	60	40	100
C	BAM 402	Complex Analysis	5	1	-	6	60	40	100
C	BAM 403	Advanced Abstract Algebra	5	1	-	6	60	40	100
SE		As per University Option	2	-	-	2	35	15	50
GE	BAM 404	GE4	5	1	-	6	60	40	100
		Life Management	2	-	-	2	35	15	50
		.				28	Total Marks		500

Bachelor of Science (Hons.) Applied Mathematics , Semester V									
Course			Instruction			Credits	Evaluation		
			Hrs. per week				External	Internal	Total
Type	Code	Title	L	T	P				
C	BAM 501	Linear Programing	5	1	-	6	60	40	100
C	BAM 502	Multivariate Calculus	5	1	-	6	60	40	100
DSE	BAM 504	DSE-1	5	1	-	6	60	40	100
DSE	BAM 505	DSE-2	5	1	-	6	60	40	100
		Life Management	2	-	-	2	35	15	50
.						26	Total Marks		450

Bachelor of Science (Hons.) Applied Mathematics , Semester VI									
Course			Instruction			Credits	Evaluation		
			Hrs. per week				External	Internal	Total
Type	Code	Title	L	T	P				
C	BAM 601	Integral Transform and Equations	5	1	-	6	60	40	100
C	BAM 602	Probability and Statistics	5	1	-	6	60	40	100
DSE	BAM 603	DSE-3	5	1	-	6	60	40	100
DSE	BAM 604	DSE-4	6	-	-	6	100	-	100
		Life Management	2	-	-	2	35	15	50
.						26	Total Marks		450

C 1.1Calculus

Credit: 6 **Maximum Marks:** 100

Unit-1

Successive differentiation and Leibnitz theorem, Maclaurin's and Taylor's theorems for expansion of a function, Indeterminate forms, Partial differentiation, Euler's theorem on homogeneous functions.

Unit-2

Curvature; Asymptotes of general algebraic curves, Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

Unit-3

Derivations and illustrations of reduction formulae of the various types, Definite Integral, Area, Volumes and surfaces of solids of revolution of cartesian, parametric and polar curves, Length of curves for cartesian, parametric and polar equations.

Unit-4

Beta and Gamma functions, properties of Beta and Gamma functions, transformation of Beta and Gamma functions, relation between Beta and Gamma functions, Duplication formula.

Unit-5

Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, velocity, tangent and normal components of acceleration.

REFERENCES:

1. G.B. Thomas and R.L. Finney: *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith: *Calculus*, 3rd Ed., Dorling Kindersley, India. (Pearson Education), 2007.
3. Khalil Ahmad: *Text Book of Calculus*, World Education Publishers, 2012.
4. Gorakh Prasad: *Calculus,* Seventeenth Edition, Reprint 2007.
5. Dr. Sanjay Agarwal, *Differential Calculus,Vigyanbodh Publication Agra, 2016.*

C 1.2 Algebra

Credit: 6 **Maximum Marks:** 100

Unit-1

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem and its applications, Hyperbolic functions, Inverse hyperbolic functions.

Unit-2

Summation of trigonometry series, C+iS method, Series of hyperbolic function,

Difference method of summing series.

Unit-3

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction.

Unit-4

Systems of linear equations, row reduction and echelon forms, rank of a matrix, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear dependence and independence.

Unit-5

Eigen values, Eigen Vectors and Characteristic Equation of a matrix, Nature of the characteristic roots of special types of matrices, Cayley-Hamilton theorem.

REFERENCES:

1. Titu Andreescu and DorinAndrica, *Complex Numbers from A to Z*, Birkhauser, 2006.
2. P. Duraipandian, Trigonometry, Emerald Publishers.
3. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
4. Shanti Narayan, Matrix, S. Chand and Company, New Delhi

C 2.1 Real Analysis

Credit: 6 **Maximum Marks:** 100

Unit-1

Algebraic and Order Properties of *R*, Neighborhood of a point in *R*, Idea of countable sets, uncountable sets and uncountability of *R*.

Unit-2

Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of *R*, The Archimedean Property, Density of Rational (and Irrational) numbers in *R*, Intervals.

Unit-3

Limit points of a set, Isolated points, Open and closed sets, Derived sets, Illustrations of Bolzano-Weierstrass theorem for sets.

Unit-4

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, Monotone Sequences, Monotone Convergence Theorem, Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion.

Unit-5

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Ratio Test, Cauchy's nth root test, Logarithmic test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

REFERENCES:

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall, 2001.
4. S. C. Malik, Principle of Real Analysis, Wiley Eastern Ltd., Delhi.

C 2.2 Differential Equations

Credit: 6 **Maximum Marks:** 100

Unit-1

Formation of differential equations, Order and degree of a differential equation, separable equations and equations reducible to this form, Homogeneous equations, exact differential equations and integrating factors, Linear differential equations and equations reducible to linear form, special integrating factors and transformations.

Unit-2

First order higher degree equation solvable for x, y, p, Clairaut's form and singular solutions, Orthogonal trajectory, Application of first order differential equations to acceleration-velocity model, Growth and decay models.

Unit-3

Statement of existence and uniqueness theorem for linear differential equations, General solution of homogeneous equation of second order, Complementary function and particular integral, Wronskian, its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation.

Unit-4

Method of variation of parameters, method of undetermined coefficients, Coupled linear differential equations with constant coefficients, Applications of second order differential equations to mechanical vibrations.

Unit-5

Power series solution, Legendre's equation, Legendre polynomials, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties.

REFERENCES:

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab,* 2nd Ed., Taylor and Francis group, London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problems Computing and Modeling*, Pearson Education India, 2005.
3. S.L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.
4. M. D. Raisinghania, Ordinary and Partial differential equations, S. Chand and Co., New Delhi.

C 3.1Theory of Real Functions

Credit: 6 **Maximum Marks:** 100

Unit-1

Limits of functions (epsilon-delta approach), sequential criterion for limits, limit theorems, continuous functions, sequential criterion for continuity and discontinuity, algebra of continuous functions, continuous functions on an interval, intermediate value theorem, uniform continuity.

Unit-2

Differentiability of a function, algebra of differentiable functions, Rolle's theorem, Lagrange's mean value theorem, intermediate value property of derivatives, Darboux's theorem.

Unit-3

Cauchy's mean value theorem, Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, Power series, radius of convergence.

Unit-4

Riemann integration, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, Riemann integrability of monotone and continuous functions, Properties of the Riemann integral.

Unit-5

Improper integrals; Convergence of Beta and Gamma functions, Pointwise and uniform convergence of sequence of functions, Theorems on continuity, derivability and integrability of the limit function of a sequence of functions.

REFERENCES:

1. R.G. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley & Sons, 2003.
2. K.A. Ross, *Elementary Analysis*, The Theory of Calculus, Springer, 2004.
3. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.
4. S. C. Malik and SavitaArora: *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 2009.

C 3.2 Abstract Algebra

Credit: 6 **Maximum Marks:** 100

Unit-1

Symmetries of a square, Binary operations, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups, Order of an element of a group, Addition and multiplication modulo

Unit-2

Subgroups and examples of subgroups, product of two subgroups, Cyclic groups, Properties of cyclic groups, Cosets, properties of cosets, Lagrange's theorem and its Corollaries, Index of subgroup of a group.

Unit-3

Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups, Centralizer, Normalizer of an element of a group, Center of a group, Classification of subgroups of cyclic groups.

Unit-4

Cycle notation for permutations, Properties of permutations, even and odd permutations, Order of a permutation, Transposition, Cycle and its length, Disjoint cycles and their examples, Permutation groups, Alternating groups, Cayley's theorem

Unit-5

Group Homomorphism, properties of homomorphisms, Isomorphisms, properties of isomorphisms Kernel of a homomorphism, First, second and third homomorphisms theorems for groups, Inner and outer automorphisms of a group.

REFERENCES:

1. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, NewDelhi, 1999.
2. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
3. Surjeet Singh and QaziZameeruddin: *Modern Algebra*, Vikas Publishing House Pvt. Ltd., New Delhi, 1994.
4. N. S. Gopalakrishan: *University Algebra* (3rd Edition), New Age International (P) Limited, New Delhi, 2015.

C 3.3 Advanced Differential Equations

Credit: 6 **Maximum Marks:** 100

Unit-1

Total differential equations, Simultaneous total differential equations, Equations of the form $dx/P = dy/Q = dz/R$, Methods of grouping and multipliers, Solution of a system of linear differential equation with constant coefficients.

Unit-2

Formation and solution of partial differential equations, Equations easily integrable. Linear partial differential equations of first order- Lagrange's equation, Non-linear partial differential equation of first order- Solution of some standard type of equations, Charpit's method.

Unit-3

Homogeneous linear partial differential equations of second and higher orders with constant coefficients, Different cases for complimentary functions and particular integrals, Non-homogeneous partial differential equations with constant coefficients.

Unit-4

Partial differential equations reducible to equations with constant coefficients, Classification of second order linear partial differential equations, Heat equation, Wave equation, Laplace equation and its solution by method of Separation of Variables.

Unit-5

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients: two equations in two unknown functions.

REFERENCES:

1. TynMyint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th Ed., Springer, Indian reprint, 2006.
2. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L A bell, James P Braselton, *Differential Equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.
4. Zafar Ahsan: *Differential Equations and their Applications*, Prentice Hall of India, 2nd Edition, 2012.
5. M. D. Raisinghania, Ordinary and Partial differential equations, S. Chand and Co., New Delhi.

C 4.1 Numerical Methods

Credit: 6 **Maximum Marks:** 100

Unit-1

Errors in numerical computations, Solution of algebraic and transcendental equations: Bisection method, false position method, Secant method, fixed point iteration method, Newton-Raphson method.

Unit-2

Solution of linear equations: Direct methods- Cramer's rule, Matrix inversion method, Gauss elimination, Gauss Jordan, LU decomposition, Indirect method- Gauss-Jacobi, Gauss-Siedel, Power method for eigenvalue problems.

Unit-3

Finite difference operators and finite differences, divided difference and its properties, Newton forward and newton backward interpolation method, stirling formula, Lagrange and Newton divided difference interpolation, Hermite interpolation method.

Unit-4

Numerical differentiation: forward difference, backward difference and central difference. Integration: trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Weddle's method

Unit-5

Numerical solution of first order differential equations by Picard's method, Euler's method, modified Euler's method and Runge-Kutta method.

REFERENCES:

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 EngineeringComputation*, 5th Ed.,New Age International Publisher, India, 2007.

3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India,7thEd., 2008.
4. S. S. Sastry: *Introductory Methods of Numerical Analysis (Fifth Ed.),* Prentice Hall of India (Ltd.) 2012.
5. M. Pal, *Numerical Analysis for Scientists and Engineers*, Narosa Publisher, 2007.

C 4.2 Complex Analysis

Credit: 6 **Maximum Marks:** 100

Unit-1

Geometric representation of a complex number, Stereographic projection, point at infinity, Functions of complex variable, Limits, Continuity, Differentiability, sufficient conditions for differentiability.

Unit-2

Analytic functions, Cauchy-Riemann equations (Cartesian and polar forms), examples of analytic functions, Orthogonal system, Harmonic and conjugate harmonic functions.

Unit-3

Elementary functions, Elementary transformations, Linear and bilinear transformations, fixed points, cross ratio, inverse point and critical points, Conformal transformation, Power series.

Unit-4

Contours, contour integrals and its examples, Cauchy theorem, Cauchy integral formula, Derivative of an analytic function, convergence of sequences and series, Taylor series and its examples, Laurent series and its examples.

Unit-5

Absolute and uniform convergence of power series, uniqueness of series representations of power series. Isolated singular points, residues, Cauchy's residue theorem, residue at infinity, types of isolated singular points, residues at poles and its examples.

REFERENCES:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed.,McGraw – Hill International Edition, 2009.
2. J.B. Conway, *Functions of Complex Variable I*, Springer Verlag, New York Inc, 1978.
3. Murray R. Spiegel, *Complex Variables*, Schaum's Outline Series, New York, 1964.
4. Ponnuswamy: An Introduction to Complex Analysis, Narosa Publication, 2011.

C 4.3 Advanced Abstract Algebra

Credit: 6 **Maximum Marks:** 100

Unit-1

Definition and examples of rings, Properties of rings, Subrings, Integral domains and fields, characteristic of a ring. Ideals, Ideal generated by a subset of a ring, Factor rings, Operations on ideals, Prime and maximal ideals.

Unit-2

Ring homomorphisms, properties of ring homomorphisms, Kernel of a homomorphism, Isomorphism and related theorems, polynomial rings over commutative rings, division algorithm.

Unit-3

Definition and examples of Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear dependence and independence, basis and dimension, direct sum of subspaces, dimension of subspaces.

Unit-4

Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations, Eigenvalues, Eigenvectors, Eigenspaces and characteristic polynomial of a linear operator.

Unit-5

Inner product spaces, norms, Cauchy-Schwartz inequality, Orthogonality, Orthonormal set, Orthonormal basis, Gram-Schmidt orthogonalization process, Bessel's inequality.

REFERENCES:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson Education India, 2003.
2. I.N. Herstein, *Topics in Algebra*, 2nd Ed., John Wiley & Sons, 2006.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
4. I. V. Krishnamurty, V.P. Mainra, J.L. Arora: *An Introduction to Linear Algebra*, East West Press , 2002.

C 5.1 Linear Programing

Credit: 6 **Maximum Marks:** 100

Unit-1

Convex sets and their properties, Linear Programming Problem: Definition, mathematical formulation, standard form, Solution space, solution– feasible, basic feasible, optimal, infeasible, multiple, redundancy, degeneracy, Graphical method for Solution of LP Problems.

Unit-2

Theory of simplex method, simplex method in tableau format, Degeneracy in Simplex methodintroduction to artificial variables, two-phase method, Big-M method.

Unit-3

Duality in LPP, formulation of the dual problem, Dual Simplex Method, revised simplex method.

Unit-4

Transportation Problem, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method Modi method),Unbalanced transportation problem, Degeneracy in transportation problems.

Unit-5

Assignment Problem, Hungarian Method for Assignment Problem, Sequencing problem, *m* machines *n* jobs problem, Graphical method for sequence problem.

REFERENCES:

1. H. Taha: *Operations Research – An Introduction*. Prentice Hall, 2010.
2. J. K. Sharma: *Operations Research – Theory and Application*, Macmillian Pub., 2007.
3. J. K. Sharma: *Operations Research – Problems and Solutions*, Macmillian Pub., 2007.
4. G. Hadley: *Linear Programming*, Narosa Publishing House, 2002.
5. S. D. Sharma: *Operations Research*, KNRN Publications, 2013.

C 5.2 Multivariate Calculus

Credit: 6 **Maximum Marks:** 100

Unit-1

Functions of several variables, limit and continuity of functions of two variables, partial differentiation, Higher order partial derivative, Tangent planes, Total differential and Chain rule, The Jacobian matrix, sufficient condition for differentiability.

Unit-3

Directional derivatives, the gradient, maximal and normal property of the gradient, maxima and minima of functions of two variables, method of Lagrange multipliers, definition of vector and scalar field, divergence and curl.

Unit-2

Double integrals, triple integrals, volume by triple integrals, cylindrical and spherical co-ordinates, change of variables in double and triple integrals, Dirichlets integral.

Unit-4

Line integrals, basic properties of line integrals, applications of line integrals: Mass and Work, fundamental theorem for line integrals, conservative vector fields

Unit-5

Green's theorem, Area as a line integral, surface integrals, Stoke's theorem, The Gauss Divergence theorem.

REFERENCES:

1. G.B. Thomas, Jr. and R.L. Finney, *Calculus: Calculus and Analytic Geometry*, 9th Ed.,Pearson Education, India, 2005.
2. M.J. Strauss, G.L. Bradley and K.J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) Pvt.Ltd. (Pearson Education), Delhi, 2007.
3. Marsden, A.J. Tromba and A. Weinstein, *Basic multivariable calculus*, Springer (SIE),Indian reprint, 2005.
4. E.Kreyzig: *Advanced Engineering Mathematics*, John Wiley and Sons, 1999.
5. S. C Malik and SavitaArora: *Mathematical Analysis*, New Age International(P) 2009.

C 6.1 Integral Transform and Equations

Credit: 6 **Maximum Marks:** 100

Unit-1

Laplace and Inverse Laplace transforms of some standard functions, Existence conditions for the Laplace transform, Shifting theorems, Transform of derivatives and integrals, Transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function.

Unit-2

Applications of Laplace and Inverse Laplace transform to solve Ordinary differential equations, Convolution theorem, Applications of Laplace transform to solve integral equations.

Unit-3

Definition and classification of linear integral equations, conversion of initial and boundary value problems into integral equations, conversion of integral equations into differential equations.

Unit-4

Fredholm and Integral Equations: Solution of integral equations with separable kernels, eigen values and eigen functions, solution by the successive approximation, resolvent kernel.

Unit-5

Volterra Integral Equations: solution by the successive approximation, resolvent kernel, equations with convolution type kernels.

REFERENCES:

1. B. Hildebrand, *Methods of Applied Mathematics*, Courier Dover Publications, 1992.
2. L. Debanth and D. Bhatta, *Integral Transforms and Their Applications*, 2nd Ed., Taylor and Francis Group, 2007.
3. Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2011.
4. Abdul J. Jerry, *Introduction to Integral Equations with Applications*, 2nd Ed., Clarkson University Wiley Publishers, 1999.
5. R. P. Kanwal, *Linear Integral Equations*, 2nd Ed., BirkhauserBosten, 1997.

C 6.2 Probability and Statistics

Credit: 6 **Maximum Marks:** 100

Unit-1

Probability: Basic concepts and definitions, Sample space and events, Axioms of Probability, conditional probability, basic laws of total probability and compound probability, Bayes' theorem.

Unit-2

Discrete and continuous random variables, mathematical expectation, variance, moment about a point, central moment, moment generating function. characteristic function, cumulative distribution function, probability mass/density functions.

Unit-3

Various discrete and continuous probability distributions: Uniform (continuous and discrete), Binomial, Negative Binomial, Poisson, Exponential.

Unit-4

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

Unit-5

Statistical Testing and Estimation Techniques: Properties of good estimator-unbiasedness, Minimum variance unbiased estimators, Method of Maximum likelihood, Confidence Intervals for mean, variance and proportions. Large sample tests for mean and proportion, chi square test for goodness of fit, Tests based on t and F-distributions.

REFERENCES:

1. Irwin Miller and Marylees Miller**,** *John E. Freund's: Mathematical Statistics with Applications*, Pearson Education, 2012

2. Robert V. Hogg, Allen Craig Deceased and Joseph W. McKean: *Introduction to Mathematical Statistics*, Pearson Education, 2012.
3. Sheldon M. Ross: *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier Academic Press, 2009.

GE 1 Quantitative Aptitude 1

Credit: 4 **Maximum Marks:** 100

Unit-1

Number System, whole numbers, decimals, fractions and relationships between numbers LCM & HCF

Unit-2

Percentage, Ratio and Proportion, Mixture and Allegation, Square roots, Problem on Ages

Unit-3

Averages, Simple and Compound Interest, Profit & Loss, Discount, Partnership

Unit-4

Time and distance, Time & work, Pipes & Cistern, Boat & Stream

Unit-5

Basic algebraic identities of School Algebra and Elementary surds, Graphs of Linear Equations.

REFERENCES:

1. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive examinations.
2. R.S. Agrawal, Quantitative Aptitude for Competitive Examinations, S. Chand Publications.

GE 2 Reasoning 1

Credit: 4 **Maximum Marks:** 100

Unit-1

Number Series, Letter and Symbol Series, Analogies, Coding and Decoding

Unit-2

Direction Sense Test, Classification, Sentence Rearrangement, Making Judgments, Verification of Truth

Unit-3

Data Sufficiency, Arithmetic Reasoning, Statement Arguments, Statement Assumption

Unit-4

Blood Relation, Syllogism, Dice Cause and Effect, Logical Sequence of Words, Venn Diagrams, Drawing inferences

Unit-5

Cube and Cuboid Analogy, Seating Arrangement, Character Puzzles, Logical Deduction, Logical Problems, Logical Games

REFERENCES:

1. R.S. Agrawal, Verbal and Non Verbal Reasoning, S. Chand Publications.
2. B.S. Sijwalii, Indu Sijwali, A New Approach to REASONING Verbal & Non-Verbal, Arihant Publication

GE 3 Quantitative Aptitude 2

Credit: 4 **Maximum Marks:** 100

Unit-1

Triangle and its various kinds of centres, Congruence and similarity of triangles, Circle and its chords

Unit-2

Quadrilaterals, Regular Polygons, Right Prism, Right Circular Cone, Right Circular Cylinder

Unit-3

Sphere, Hemispheres, Rectangular Parallelepiped, Regular Right Pyramid with triangular or square base

Unit-4

Trigonometric ratio, Degree and Radian Measures, Standard Identities, Complementary angles

Unit-5

Heights and Distances, Histogram, Frequency polygon, Bar diagram & Pie chart Data interpretation

REFERENCES:

a. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive examinations.
b. R.S. Agrawal, Quantitative Aptitude for Competitive Examinations, S. Chand Publications.

GE 4 Reasoning 2

Credit: 4 **Maximum Marks:** 100

Unit-1

Series, Figure Matrix, Non Verbal Analogy, Analytical Reasoning, Date & city matching

Unit-2

Mirror and Water Images, Embedded Images, Pattern Completion, Paper Folding, Paper Cutting

Unit-3

Rule Detection, Non Verbal Classification, Grouping of Images, Dot Situation

Unit-4

Shape Construction, Image Analysis, Cubes and Dice

Unit-5

Trends, Space Orientation, Space Visualization, Critical thinking, Emotional Intelligence, Social Intelligence

REFERENCES:

1. R.S. Agrawal, Verbal and Non Verbal Reasoning, S. Chand Publications.
2. B.S. Sijwalii, Indu Sijwali, A New Approach to REASONING Verbal & Non-Verbal, Arihant Publication

DSE 1.1 Discrete Mathematics

Credit: 6 **Maximum Marks:** 100

Unit-1

Basic Concepts of Set Theory, Algebra of sets and duality, Inclusion- exclusion principle, Mathematical induction, Cartesian product, Ordering and Relation, Types of Relations- binary Relation, Equivalence relation, Partial order relation.

Unit-2

Basic counting principle, Factorial, Binomial and multinomial coefficients Permutation, Permutation with repetitions, Combination, Pigeonhole principle, ordered and unordered partitions.

Unit-3

Logic and Basic Logical operations - Conditional &Biconditional statements, Negation Operation, truth Tables, Logic Connectives and compound statements, Conjunction, Disjunction, Dulity, Conditional and inconditional statements.

Unit-4

Boolean algebra, Duality, Properties of Boolean algebra, Boolean subalgebra, Boolean algebra as lattices, Boolean functions, Types of Boolean functions, Logic circuits and logic gates.

Unit-5

Graph, Directed & Undirected graphs, Finite and infinite graphs, Incidence and degree, Null graph, Subgraphs, Walks, Paths and circuits in a graphs,

Operations on graphs, Connected and disconnected graphs, Euler's graphs. Trees, properties of trees, Rooted trees, Binary trees.

REFERENCES:

1. Seymour Lipschutz, Marc Lipson, Schaum's Easy outline of Discrete mathematics, Tata McGraw hill.
2. R. Krishana Kumar, Discrete Mathematics, Laxmi Publication ltd.
3. C.L. Liu, Elements of Discrete Mathematics, (Second Edition), McGraw Hill, International Edition.
4. NarsinghDeo, Graph theory with applications to engineering and computer science, PHI Learning private limited New Delhi-110001, 2010.

DSE 1.2 Mathematical Modeling

Credit: 6 **Maximum Marks:** 100

Unit-1

Introduction- Definition & Simple situations for Mathematical Modelling, Technique of Mathematical Modelling, Classification of Mathematical Models, Some characteristic of Mathematical Models, Mathematical models based on Geometry, Algebra and Calculus.Limitations of Mathematical Modelling.

Unit-2

Mathematical Modelling through ODE: Linear Growth and Decay Models, Non-linear Growth and Decay Models, Compartmental Models, Mathematical Modelling in Population Growth, Compartment models.

Unit-3

Mathematical modeling through systems of first order ODE: Models of population dynamics and epidemics, Compartment model, Mathematical Modelling for planetary motions, Mathematical Modelling for Circular motion and motion of satellites.

Unit-4

Mathematical modeling through PDEs: Mass-balance equations, Momentum balance equations, Variational principles, Model for traffic on a highway.

Unit-5

Difference Equations: Formation of difference equations, First order difference equations: Homogeneous, Non-homogeneous, Second order linear difference equations: Homogeneous equations , Auxiliary equation, non-homogeneous equations. Applications of difference equations (Models).

REFERENCES:

1. J. N. Kapoor, Mathematical Modeling, New Age Internationals, 1988.
2. J.N. Kapoor, Mathematical Models in Biology and medicine. Affiliated east-West Press 1985.
3. B. S. Grewal: *Higher Engineering Mathematics*, Khanna Publication, 2014.

DSE 2.1 Mechanics

Credit:6 **Maximum Marks:** 100

Unit-1

Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, Center of gravity of any arc of a curve, Center of gravity of any plane area.

Unit-2

Virtual work, principle of virtual work for a system of coplanar forces acting on a particle, principle of virtual work for a number of coplanar forces acting on different parts of rigid body, tension and thrust.

Unit-3

Kinematics, motion in a straight line and a plane, radial and transverse velocities and accelerations, angular velocity and acceleration, tangential and normal components of acceleration.

Unit-4

Rectilinear motion with constant acceleration, Simple harmonic motion.

Unit-5

Hooke's law, repulsion from a fixed point varying as the distance from the point, motion under inverse square law and other laws of force.

REFERENCES:

1. I.H. Shames and G. Krishna Mohan Rao, *Engineering Mechanics: Statics and Dynamics*, 4thEd., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, *Engineering Mechanics: Statics and Dynamics*, 11th Ed.,Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.
3. M. ray and G.C. Sharma, A text book on dynamics, S. Chand and company Ltd., New Delhi.
4. R.S. Verma, Text book on Statics, Pothishalapvt. Ltd., Allahabad.

DSE 2.2 Metric Space

Credit: 6 **Maximum Marks:** 100

Unit-1

Triangle, Holder's, Cauchy-Schwarz, Minkowski's inequality (with proof), Definition and examples of metric spaces.

Unit-2

Open and closed spheres, Neighbourhood of a point, Open sets, Interior points, Limit points, Closed sets and closure of a set, Boundary points, diameter of a set, Equivalent metrics, Subspace of a metric space.

Unit-3

Convergent and Cauchy sequences, Complete metric space, Continuous functions and their characterizations.

Unit-4

Compact spaces, Sequential compactness and Bolzano-Weierstrass property, Finite Intersection property, Continuous functions and compact sets.

Unit-5

Disconnected and connected sets, connected subsets of R, Continuous functions and connected sets.

REFERENCES:

1. E.T. Copson: *Metric Spaces,* Cambridge University Press, 1968.
2. P.K. Jain and Khalil Ahmad: *Metric Spaces*, Second Edition, Narosa Publishing House, New Delhi, 2003.
3. B. K. Tyagi: *First Course in Metric Spaces,* Cambridge University Press, 2010.

DSE 3.1 Analytic Geometry of 3D

Credit: 6 **Maximum Marks:** 100

Unit-1

System of coordinate, Direction Cosines, Angle between two lines, Projection, Distance of a point from a line, Change of axes, Translation and Rotation, Invariants, Conic sections.

Unit-2

General equation of a plane, Normal form and intercept form of the equation of a plane, Transformation from general form to normal form, Equation of plane through three points, Angle between two planes, Perpendicular distance of a point from the planes.

Unit-3

General equation of a straight line, Symmetric form of the equation of straight line, Line through two points, Transformation from the general form to symmetrical form, Perpendicular distance formula for a line, Shortest distance between two lines.

Unit-4

General equation of a sphere, Plane section of a sphere, Intersection of two sphere, Spheres through a given circle, Intersection of a straight line and a sphere, Equation of a tangent plane to sphere, Condition of tangency, Polar plane of a given plane, Angle of intersection of two spheres.

Unit-5

Equation of a cone whose vertex is at origin, Equation of a cone with a given vertex and a given conic as base, Condition that general equation of a second degree represent a cone, Equation of a tangent plane, Reciprocal cone, Right circular cone.

REFERENCES:

1. Shanti Narayan, Analytical Solid Geometry, S. Chand & Co., Delhi.
2. S. L. Loney, The elements of co-ordinate geometry, Macmillan and company, London.
3. Gorakh Prasad and H.C. Gupta, Text book on co-ordinate geometry, Pothishala Private Ltd., Allahabad, U.P.
4. R.J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., 1994.

DSE 3.2 Differential Geometry

Credit: 6 **Maximum Marks:** 100

Unit-1
Tensors: Summation convention, co-ordinate transformation, Scalar, contra variant and covariant vectors, Tensors of higher rank, Algebra of tensors and contraction, Metric tensor and 3-index Christo fell symbols, covariant derivative of contra variant, covariant vectors and higher rank tensors.

Unit-2
Curves in R^3 : Representation of curves, unit speed curves, tangent to a curve, principal vector and binormal vector , osculating plane, normal plane and rectifying plane, curvature and torsion, Serret - Frenet formula, Helix.

Unit-3
Behaviors of curve near a point, osculating circle and osculating sphere, Necessary and sufficient condition for a curve to lie on a sphere, involutes and evolutes, Fundamental existence theorem for space curves.

Unit-4
Surface in R^3: Definition and examples of a smooth surface, tangent plane and unitsurface normal, Surface of revolution, first fundamental form and its properties.

Unit-5
Direction co-efficient on a surface, angle between tangential direction on a surface, second fundamental form, normal curvature, Principal curvature, Shape operator and its properties.

REFERENCES:

1. B.O. Neill: *Elementary Differential Geometry*, Academic Publishers, 2006.
2. Andrew Pressley: *Elementary Differential Geometry*, Springer, 2010.
3. M. P. Do Carmo: *Differential Geometry of Curves and Surfaces*, Prentice Hall, 1976.
4. T. G. Willmore: *Introduction to Differential Geometry*, Oxford University Press, 1959.
5. D. Somasundaram: *Differential Geometry*, Narosa Publishing House, 2005.

DSE 4 PROJECT

Credit: 6 **Maximum Marks:** 100

Project report should be prepared in consultation with the guide. It should clearly state the objectives and environment of the proposed project to be undertaken. Ensure to include the following items while submitting your project report. Project report may contain 20-30 pages and sequence of contents strictly should be in the following order:

1. Cover and Title page
2. Candidate Declaration
3. Acknowledgement
4. Abstract
5. Table of Contents
6. Conclusion
7. Bibliography/ References