Proposed syllabus
for

B.A. (Prog.)- Mathematics Papers

CBCS

Department of Mathematics
University of Delhi
Delhi-110007

Sl. No.	CORE COURSE (12)	Ability Enhancement Compulsory Course	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective DSE (6)
I	Calculus			
II	Algebra			
III	Analytic Geometry and Applied Algebra		SEC-1 LaTeX and HTML	
IV	Analysis		SEC-2 Computer Algebra Systems and Related Softwares	
V			SEC-3 Operating System: Linux	DSE-1 (I) Differential Equations or (ii) Discrete Mathematics
VI			SEC-4 Transportation and Game Theory	DSE-2 (I) Numerical Analysis or (ii) Statistics

Semester-I

Paper I Calculus
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

SECTION – I
Limit and.Continuity, Types of discontinuities. Differentiability of functions. Successive differentiation, Leibnitz.s theorem, Partial differentiation, Euler's theorem on homogeneous functions.

SECTION - II
Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves.

SECTION – 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(l+x), $(l+x)^m$, Applications of Mean Value theorems to Monotonic functions and inequalities. Maxima & Minima. Indeterminate forms.

Books Recommended:

1. George B. Thomas, Jr., Ross L. Finney : *Calculus and Analytic Geometry*, Pearson Education (Singapore); 2001.
2. H. Anton, I. Bivens and S. Davis : Calculus, John Wiley and Sons (Asia) Pte. Ltd. 2002.
3. R.G. Bartle and D.R. Sherbert : Introduction to Real Analysis, John Wiley and Sons (Asia) Pte. Ltd. 1982

Semester-II

Paper II **Algebra**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

SECTION - I

Definition and examples of a vector space, Subspace and its properties, Linear independence and dependence of vectors, basis and dimension of a vector space. 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. Cayley-Hamilton theorem, Characteristic roots and vectors.

SECTION - II

De Moivre.s theorem (both integral and rational index). Solutions of equations using trigonometry, Expansion for Cos nx. Sin nx in terms of powers of Sin x, Cosx, and $Cos^n x$, $Sin^n x$ in terms of Cosine and Sine of multiples of x, Summation of series, Relation between roots and coefficients of n^{th} degree equation. Solutions of cubic and biquadratic equations, when some conditions on roots of the equation are given, Symmetric functions of the roots for cubic and biquadratic equations.

SECTION - III

Integers modulo n, Permutations, Groups, subgroups, Lagrange's Theorem, Euler's Theorem, Symmetry Groups of a segment of a line, and regular n-gons for n=3, 4, 5 and 6. Rings and subrings in the context of C[0,1] and Z_n.

Recommended Books:

1. Abstract Algebra with a Concrete Introduction, John A. Beachy and William D. Blair, Prentice Hall, 1990.
2. Modern Abstract Algebra with Applications, W.J. Gilbert, John Wiley & Sons 1976.

Semester-III

Paper III : **Analytic Geometry and Applied Algebra**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

SECTION-I : Geometry
Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola and their applications to signals, classification of quadratic equation representing lines, parabola, ellipse and hyperbola.

SECTION-II : 3-Dimensional Geometry and Vectors
Rectangular coordinates in 3-space; spheres, cylindrical surfaces cones. Vectors viewed geometrically, vectors in coordinate system, vectors determine by length and angle, dot product, cross product and their geometrical properties. Parametric equations of lines in plane, planes in 3-space.

SECTION - III : Applied Algebra
Latin Squares, Table for a finite group as a Latin Square, Latin squares as in Design of experiments, Mathematical models for Matching jobs, Spelling Checker, Network Reliability, Street surveillance, Scheduling Meetings, Interval Graph Modelling and Influence Model, Picher Pouring Puzzle,.

Recommended Books:
1. Calculus, H. Anton, 1. Birens and S.Davis, John Wiley and Sons, Inc. 2002.
2. Applied Combinatorics, A Tucker, John Waley & Sons, 2003.

Semester-IV

Paper IV : **Analysis**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

SECTION-I
Order completeness of Real numbers, open and closed sets, limit point of sets, Bolzano Weierstrass Theorem, properties of continuous functions, Uniform continuity.

SECTION-II
Sequences, convergent and Cauchy sequences, sub-sequences, limit superior and limit inferior of a sequence, monotonically increasing and decreasing sequences, infinite series and their convergences, positive term series, comparison tests, Cauchy's nth root test, D. Alembert's ratio test, Raabe's test, alternating series, Leibnitz's test, absolute and conditional convergence.

SECTION-III
Riemann integral, integrability of continuous and monotonic functions

Books Recommended:
1. R.G. Bartle and D.R.Sherbert, Introduction to Real Analysis, John Wiley and Sons (Asia) Pvt. Ltd., 2000.
2. Richard Courant & Fritz John, Introduction to Calculus and Analysis I, Springer-Verlag, 1999.
3. S. K. Berbarian, Real Analysis, Springer - Verlag, 2000.

Semester-V

DSE-1

(I) Differential Equations

or

(ii) Discrete Mathematics

Paper V **Differential Equations**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

Ordinary differential equations
First order exact differential equations including rules for finding integrating factors, first order higher degree equations solvable for x, y, p, Wronskian and its properties, Linear homogeneous equations with constant coefficients, Linear non-homogeneous equations. The method of variation of parameters. Euler's equations. Simultaneous differential equations. Total differential equations.

Partial differential equations
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 equations of first order, Lagrange.s method, Charpit.s method, classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Recommended Books:
1. Calculus, H. Anton, 1. Birens and S.Davis, John Wiley and Sons, Inc. 2002.
2. Differential Equations, S.L.Ross, John Wiley and Sons, Third Edition, 1984.
3. Elements of Partial Differential Equations, I.Sneddon, McGraw-Hill International Editions, 1967.

or

Paper V **Discrete Mathematics**

Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

SECTION-I

Definition, examples and properties of posets, maps between posets, Algebraic lattice, lattice as a poset, duality principal, sublattice ,Hasse diagram. Products and homomorphisms of lattices, Distributive lattice, complemented lattice.
Boolean Algebra, Boolean polynomial, CN form, DN form.

SECTION-II

Simplification of Boolean polynomials, Karnaugh diagram. Switching Circuits and its applications. Finding CN form and DN form, Graphs, subgraph, complete graph, bipartite graph, degree sequence, Euler's theorem for sum of degrees of all vertices.

SECTION-III

Eulerian circuit, Seven bridge problem, Hamiltonian cycle, Adjacency matrix.
Dijkstra's shortest path algorithm (improved version). Chinese postman problem, Digraphs. Definitions and examples of tree and spanning tree , Kruskal's algorithm to find the minimum spanning tree. Planar graphs, coloring of a graph and chromatic number.

References:

[1] Applied Abstract Algebra (2nd Edition) Rudolf Lidl, Gunter Pilz, Springer, 1997.
[2] Discrete Mathematics with Graph Theory (3rd Edition) Edgar G. Goodaire, Michael M. Parmenter, Pearson, 2005.
[3] Discrete Mathematics and its applications with combinatorics and graph theory by Kenneth H Rosen (7th Edition), Tata McGrawHill Education private Limited, 2011.

Semester-VI

DSE-2

(I) Numerical Analysis

or

(ii) Statistics

Paper VI **Numerical Analysis**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

Section-I

Significant digits, Error, Order of a method, Convergence and terminal conditions, Efficient computations Bisection method, Secant method, RegulaFalsi method, Newton Raphson method, Newton's method for solving nonlinear systems

Section-II

Gauss elimination method (with row pivoting) and Gauss□Jordan method, Gauss Thomas method for tridiagonal systems Iterative methods: Jacobi and Gauss-Seidel iterative methods Interpolation: Lagrange's form and Newton's form Finite difference operators, Gregory Newton forward and backward differences Interpolation

Section-III

Numerical differentiation: First derivatives and second order derivatives, Numerical integration: Trapezoid rule, Simpson's rule (only method), Newton□Cotes open formulas, Extrapolation methods: Romberg integration, Gaussian quadrature, Ordinary differential equation: Euler's method Modified Euler's methods: Heun method and Mid-point method, Runge-Kutta second methods: Heun method without iteration, Mid-point method and Ralston's method Classical 4^{th} order Runge-Kutta method, Finite difference method for linear ODE

REFERNCES:

[1] Laurence V. Fausett, Applied Numerical Analysis, Using MATLAB, Pearson, 2/e (2012)
[2] M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publisher, 6/e (2012)
[3] Steven C Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata McGraw Hill, 2/e (2010)

Or

Paper VI **Statistics**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

Section-I

Probability Classical, relative frequency and axiomatic approaches to probability. Theorems of total and compound probability. Conditional probability, independent events, Bayes Theorem. Random Variables. Discrete and continuous random variables, Distribution function, Expectation of a random variable, Moments, moment generating functions.

Section-II

Discrete and continuous distribution, Bionomial, Poisson, geometric. Normal and exponential distributions, bivariate distribution, conditional distribution and marginal distribution, Correlation and regression for two variables, weak law of large numbers, central limit theorem for independent and identically distributed random variables.

Section-III

Statistical inference, definition of random sample, parameter and statistic concept of sampling distribution standard error, sampling distribution of mean variance of random sample from a normal population, Test of significance based on F and chi-square distribution t and F.

REFERENCES:

1. Robert V. Hogg, Joseph W. Mc Kean and Allen T. Craig. Introduction of Mathematical Statistics, Pearson Education, Asia, 2007
2. Irvin Miller and Marylees Miller, John E. Freund's Mathematical Statistics with Applications (7_{th}Ed$_n$), Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models (9_{th} Edition), Academic Press, Indian Reprint, 2007

Skill Enhancement Course Papers

SEC-1 LaTeX and HTML
2L+ 2Practical per week

Elements of LaTeX; Hands-on-training of LaTex; graphics in LaTeX; PSTricks; Beamer presentation; HTML, creating simple web pages, images and links, design of web pages.

[1] Chapter 9-11, 15

Practical

Six practical should be done by each student. The teacher can assign practical from the exercises from [1].

References:

[1] Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.
[2] L. Lamport. LATEX: A Document Preparation System, User's Guide and ReferenceManual. Addison-Wesley, New York, second edition, 1994.

SEC-2 Computer Algebra Systems and Related Softwares
2L+ 2Practical per week

Use of Mathematica, Maple, and Maxima as calculator, in computing functions, in making graphs; MATLAB/Octave for exploring linear algebra and to plot curve and surfaces; the statistical software R: R as a calculator, explore data and relations, testing hypotheses, generate table values and simulate data, plotting.

[1] Chapter 12-14

Practical

Six practical should be done by each student. The teacher can assign practical from the exercises from [1].

References:

[1] Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.
[2] L. Lamport. LATEX: A Document Preparation System, User's Guide and ReferenceManual. Addison-Wesley, New York, second edition, 1994.

SEC-3 Operating System: Linux
2L+ 2Practical per week

The Operating System: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, Overview of Linux architecture, Installation, Start up scripts, system processes (an overview), Linux Security, The Ext2 and Ext3 File systems: General Characteristics of, The Ext3 File system, file permissions. User Management: Types of users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools. Resource Management in Linux: file and directory management, system calls for files Process Management, Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls for processes, Memory Management, library and system calls for memory.

References:

[1] Arnold Robbins, Linux Programming by Examples The Fundamentals, 2nd Ed., Pearson Education, 2008.
[2] Cox K, Red Hat Linux Administrator's Guide, PHI, 2009.
[3] R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.
[4] Sumitabha Das, Unix Concepts and Applications, 4th Ed., TMH, 2009.
[5] Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, 6th Ed., O'Reilly Media, 2009.
[6] Neil Matthew, Richard Stones, Alan Cox, Beginning Linux Programming, 3rd Ed., 2004.

SEC-4 Transportation and Game Theory
2L+ 1 Tutorial per week

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

References:

[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.