S. No.	Existing	Proposed
1	Skill Enhancement Courses (SEC) offered to B.Sc. (H) Mathematics (in 3rd and 4th Semester) are of 3 Credits	Since these courses should of 4 Credits according to UGC Guidelines, amendments have been made in the existing Courses to make them of 4 Credits
2	Skill Enhancement Courses (SEC) offered to B.A./ B.Sc. Programme (in 3rd, 4th, 5th and 6th Semesters) are of 3 Credits	Since these courses should of 4 Credits according to UGC Guidelines, amendments have been made in the existing Courses to make them of 4 Credits
3	Only One Generic Elective Paper is offered (in 1st, 2nd and 3rd Semester) to students of B.Sc. (H), B.A. (H) & B.Com (H) other than B.Sc. (H) Mathematics.	Two Generic Elective Papers are now offered each semester to students of B.Sc. (H), B.A. (H) & B.Com (H) other than B.Sc. (H) Mathematics.
4	No Generic Elective papers were being offered to students of B.A, B.Sc. & B.Com Programme in the 5th and 6th Semester	Generic Elective papers are now offered to students of B.A, B.Sc. & B.Com Programme in the 5th and 6th Semester

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3

GENERIC ELECTIVE COURSES
OFFERED TO
B.SC. (H)/ B. A. (H)/ B. Com (H)
OTHER THAN
B.SC. (H) MATHEMATICS

Semester	Core Course (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	Generic Elective (GE) (4)
I					**GE-1** Calculus OR Analytic Geometry and Theory of Equations
II					**GE-2** Linear Algebra OR Discrete Mathematics
III					**GE-3** Differential Equations OR Linear Programming and Game Theory
IV					**GE-4** Numerical Methods OR Elements of Analysis
V					
VI					

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Semester I

GE- 1: CALCULUS
OR
GE- 1: ANALYTIC GEOMETRY AND THEORY OF EQUATIONS

GE- 1: CALCULUS

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT-I

ε-δ Definition of limit of a function, One sided limit, Limits at infinity, Horizontal asymptotes, Infinite limits, Vertical asymptotes, Linearization, Differential of a function, Concavity, Points of inflection, Curve sketching, Indeterminate forms, L'Hopital's rule, Volumes by slicing, Volumes of solids of revolution by the disk method.

UNIT-II

Volumes of solids of revolution by the washer method, Volume by cylindrical shells, Length of plane curves, Area of surface of revolution, Improper integration: Type I and II, Tests of convergence and divergence, Polar coordinates, Graphing in polar coordinates, Vector valued functions: Limit, Continuity, Derivatives, Integrals, Arc length, Unit tangent vector.

UNIT-III

Curvature, Unit normal vector, Torsion, Unit binormal vector, Functions of several Variables, Graph, Level curves, Limit, Continuity, Partial derivatives, Differentiability Chain Rule, Directional derivatives, Gradient, Tangent plane and normal line, Extreme values, Saddle points

REFERENCES:

[1] G. B. Thomas and R. L. Finney, Calculus, Pearson Education, 11/e (2012)
[2] H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons Inc., 7/e (2011)

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OR

GE- 1: ANALYTIC GEOMETRY AND THEORY OF EQUATIONS

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT-I

Conic sections and quadratic equations: circle, parabola, ellipse, hyperbola, Techniques for sketching parabola, ellipse and hyperbola, Reflection properties of parabola, ellipse and hyperbola, classifying conic sections by eccentricity, Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. Parameterization of plane curves, conic sections in polar coordinates and their sketching

Unit-II

Rectangular coordinates in 3-space, spheres and cylindrical surfaces, 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 2-space and 3-space

UNIT-III

General properties of polynomials and equations, Descarte's rule of signs-positive, negative and imaginary roots, Relation between the roots and the coefficients of equations, Applications, depression of an equation when a relation exists between two of its roots, Symmetric functions of the roots and its applications, Transformation of equations (multiplication, reciprocal, increase/ diminish in the roots by given quantity), removal of terms, Graphical representation of derived function, Rolle's theorem, multiple roots of the equation.

REFERENCES:

[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, 2002.
[3] W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.

Semester II

GE- 2: LINEAR ALGEBRA
OR
GE- 2: DISCRETE MATHEMATICS

GE- 2: LINEAR ALGEBRA

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT-I

Fundamental operation with vectors in Euclidean space $\mathbf{R}^n$, Linear combination of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality, Projection vectors, Some elementary results on vector in $\mathbf{R}^n$, Matrices, Gauss–Jordan row reduction, Reduced row echelon form, Row equivalence, Rank, Linear combination of vectors, Row space, Eigenvalues, Eigenvectors, Eigenspace, Characteristic polynomials, Diagonalization of matrices, Definition and examples of vector space, Some elementary properties of vector spaces, Subspace.

UNIT-II

Span of a set, A spanning set for an eigenspace, Linear independence and linear dependence of vectors, Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets, Application of rank, Homogenous and nonhomogenous systems of equations, Coordinates of a vector in ordered basis, Transition matrix, Linear transformations: Definition and examples, Elementary properties, The matrix of a linear transformation, Linear operator and Similarity.

UNIT-III

Application: Computer graphics- Fundamental movements in a plane, Homogenous coordinates, Composition of movements, Kernel and range of a linear transformation, Dimension theorem, One to one and onto linear transformations, Invertible linear transformations, Isomorphism: Isomorphic vector spaces (to $\mathbf{R}^n$), Orthogonal and orthonormal vectors, Orthogonal and orthonormal bases, Orthogonal complement, Projection theorem (Statement only), Orthogonal projection onto a subspace, Application: Least square solutions for inconsistent systems.

REFERENCES:

[1] S. Andrilli and D. Hecker, Elementary Linear Algebra, Academic Press, 4/e (2012)
[2] B. Kolman and D.R. Hill, Introductory Linear Algebra with Applications, Pearson Education, 7/e (2003)

OR

GE- 2: DISCRETE MATHEMATICS

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT-I

Compound Statements (and, or, implication, negation, contrapositive, quantifiers), truth tables, basic logical equivalences and its consequences, logical arguments, Set theory, operation on sets, types of binary relations, equivalence relation, partial and total ordering, lattices, properties of integers, division algorithm, divisibility and Euclidean algorithm, gcd, lcm, relatively prime, prime numbers, statement of fundamental theorem of arithmetic, Fermat primes,

UNIT-II

Congruences and its properties, Mathematical induction, recursive relations and its solution (characteristics polynomial and generating function), principles of counting (inclusion/ exclusion, pigeon-hole) , permutation and combinations (with and without repetition),

UNIT-III

Duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms, distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

REFERENCES:

[1]. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
[2]. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory* (2nd Edition), Pearson Education (Singapore) Pte. Ltd., Indian Reprint 2003.
[3]. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra* (2nd Edition), Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
[4]. Kenneth H Rosen, *Discrete Mathematics and its applications* (7th Edition), Tata McGrawHill Education Private Limited, 2011.

Semester III

GE- 3: DIFFERENTIAL EQUATIONS
OR
GE- 3: LINEAR PROGRAMMING AND GAME THEORY

GE- 3: DIFFERENTIAL EQUATIONS

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT-I

First order ordinary differential equations: Basic concepts and ideas, Exact differential equations, Integrating factors, Bernoulli equations, Orthogonal trajectories of curves, Existence and uniqueness of solutions, Second order differential equations: Homogenous linear equations of second order, Second order homogenous equations with constant coefficients, Differential operator, Euler-Cauchy equation.

UNIT-II

Existence and uniqueness theory, Wronskian, Non-homogenous ordinary differential equations, Solution by undetermined coefficients, Solution by variation of parameters, Higher order homogenous equations with constant coefficients, System of differential equations, System of differential equations, Conversion of *n*th order ODEs to a system, Basic concepts and ideas, Homogenous system with constant coefficients.

UNIT-III

Power series method: Theory of power series methods, Legendre's equation, Legendre polynomial, Partial differential equations: Basic Concepts and definitions, Mathematical problems, First order equations: Classification, Construction, Geometrical interpretation, Method of characteristics, General solutions of first order partial differential equations, Canonical forms and method of separation of variables for first order partial differential equations, Classification of second order partial differential equations, Reduction to canonical forms, Second order partial differential equations with constant coefficients, General solutions.

REFERENCES:

[1] Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc., 9/e, (2006)
[2] TynMyint–U and Lokenath Debnath; Linear Partial Differential Equations for Scientists and Engineers, Springer, Indian Reprint (2009)

OR

GE- 3: LINEAR PROGRAMMING AND GAME THEORY

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT-I

Introduction to linear programming problem, Graphical method of solution, Basic feasible solutions, linear programming and Convexity, Introduction to the Simplex method, Theory of the Simplex method, Optimality and Unboundedness, The simplex tableau and examples, Artificial variables, Introduction to duality, Formulation of the dual problem and its examples, Duality Theorem and its applications

UNIT-II

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-III

Introduction to Game theory, Formulation of two-person zero sum rectangular game, Solution of rectangular games with saddle points, dominance principle; rectangular games without saddle point –mixed strategy, Graphical, algebraic and linear programming solution of m x n games

REFERENCES:

[1]. Paul R. Thie and Gerard E. Keough, *An Introduction to Linear Programming and Game Theory*, Third Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
[2]. Hamdy A. Taha, *Operations Research: An Introduction*, Ninth Edition, Prentice Hall, 2011.
[3]. Frederick S. Hillier and Gerald J. Lieberman, *Introduction to Operations Research*, Ninth Edition, McGraw-Hill, Inc., New York, 2010.

Semester IV

GE- 4: NUMERICAL METHODS
OR
GE- 4: ELEMENTS OF ANALYSIS

GE- 4: NUMERICAL METHODS

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT-I

Floating point representation and computer arithmetic, Significant digits, Errors: Roundoff error, Local truncation error, Global truncation error, Order of a method, Convergence and terminal conditions, Efficient computations Bisection method, Secant method, Regula-Falsi method, Newton Raphson method, Newton's method for solving nonlinear systems

UNIT-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.

UNIT-III

Piecewise polynomial interpolation: Linear interpolation, Cubic spline interpolation (only method), Numerical differentiation: First derivatives and second order derivatives, Richardson extrapolation 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 4th 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

GE- 4: ELEMENTS OF ANALYSIS

5 Lectures + 1 Tutorial per week (Ideal Tutorial Group Size: 12-15 Students)
Max. Marks: 100 (including internal assessment)
Examination: 3 hrs

UNIT I

Finite and infinite sets examples of countable and uncountable sets. Real line; absolute value bounded sets suprema and infima, statement of order Completeness property of R, Archimedean property of R, intervals. Real sequences, Convergence, sum and product of convergent sequences, proof of convergence of some simple sequences such as $(-1)^n/n$, $1/n^2$, $(1+1/n)^n$, x^n with $|x|<1$, a_n/n, where a_n is a bounded sequence, Concept of cluster points and statement of Bolzano Weierstrass' theorem, Statement and illustration of Cauchy convergence criterion for sequences, Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence

UNIT II

Definition and a necessary condition for convergence of an infinite series, Cauchy convergence criterion for series, positive term series, geometric series, comparison test, limit comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test. Definition and examples of absolute and conditional convergence

UNIT III

Definition of power series: radius of convergence, Cauchy-Hadamard theorem, statement and illustration of term-by-term differentiation and integration of power series, Power series expansions for exp(x), sin(x), cos(x), log(1+x) and their properties

REFERENCES:

[1] R.G. Bartle and D.R. Sherbert: *Introduction to Real Analysis*, John Wiley and Sons (Asia) Pte. Ltd., 2000.

[2] C. P. Simon and L. Blume: *Mathematics for Economists*, W W Norton and Company, 1994.

[3] K. Sydsaeter and P.J. Hammod, *Mathematics for Economics Analysis*, Pearson Education, 2002

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