3 Yr. Degree Course
(Minor)
based on NEP-2020
MATHEMATICS

(Effective from Session 2025-26)

(Batch: 2025-2028)

SAMBALPUR UNIVERSITY

JYOTI-VIHAR, BURLA, SAMBALPUR, ODISHA-768019

COURSE AT A GLANCE (NEP-U.G.)

SUBJECT: MATHEMATICS *ACADEMIC SESSION:* **2025-28**

CORE-I COURSE

Course Number	Semester	Course Title	Type of Paper P-Practical NP-Non-practical	Credit Hour	Maximum Weightage of Marks
Paper-I	I	Calculus and Analytic Geometry	NP	4	100
Paper-II		Introduction to Algebra & Number Theory	NP	4	100
Paper-III	II	Real Analysis-I	NP	4	100
Paper-IV		Algebra-I	NP	4	100
Paper-V	III	Probability	NP	4	100
Paper-VI		Differential Equations-I	P	4	100
Paper-VII		Linear Algebra	NP	4	100
Paper-VIII	IV	Real Analysis-II	NP	4	100
Paper-IX		Complex Analysis-I	NP	4	100
Paper-X		Algebra-II	NP	4	100
Paper-XI	V	Differential Equations-II	P	4	100
Paper-XII		Real Analysis-III	NP	4	100
Paper-XIII		Numerical Analysis & Scientific Computing	P	4	100
Paper-XIV	VI	Multivariable Calculus	NP	4	100
Paper-XV		Differential Geometry	NP	4	100
Paper-XVI	VII	Measure Theory & Integration	NP	4	100
Paper-XVII		Algebra-III	NP	4	100
Paper-XVIII		Topology	NP	4	100

Paper-XIX		Mathematical Methods	NP	4	100
Paper-XX	VIII	Functional Analysis	NP	4	100
Paper-XXI		Analytic Number Theory	NP	4	100
Paper-XXII		Complex Analysis-II	NP	4	100
Paper-XXIII		Differential Equations-III	NP	4	100

CORE-II/CORE-III COURSE

Course Number	Semester Core-II/ Core-III	Course Title	Type of Paper P-Practical NP-Non-practical	Credit Hour	Maximum Weightage of Marks
Paper-I	I/II	Calculus & Analytic Geometry	NP	4	100
Paper-II	III/IV	Introduction to Algebra & Number Theory	NP	4	100
Paper-III	V/VI	Real Analysis-I	NP	4	100
Paper-IV	VII	Linear Algebra	NP	4	100
Paper-V	VIII	Multivariable Calculus	NP	4	100

CORE COURSE II/ III

Minor (Paper-I) Semester I/II

CALCULUS & ANALYTIC GEOMETRY

Objective: The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of mathematical nature as well as practical problems. More precisely, main target of this course is to explore the different tools for higher order derivatives to plot the various curves and to solve the problems associated with differentiation and integration of vector functions.

Learning Outcomes: After completing the course the student will be able to

CO1: trace a curve and find asymptotes.

CO2: calculate integrals of typical type using reduction formulae, etc.

CO3: calculate arc length, surface of revolution and know about conics

CO4: calculate triple products, gradient divergence, curl, etc.

UNIT-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type $e^{ax+b}sinx$, $e^{ax+b}cosx$, $(ax+b)^n sinx$, $(ax+b)^n cosx$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital rule, application in business, economics and life sciences.

UNIT-II

Riemann integration as a limit of sum, integration by parts, reduction formulae, derivations and illustrations of reduction formulae of the type $\int sin^n x dx, \int cos^n x dx, \int tan^n x dx, \int sec^n x dx$, $\int (log x)^n dx, \int sin^n x cos^n x dx$, definite integral, integration by substitution.

UNIT-III

Volumes by slicing, disks and washer's methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

UNIT-IV

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation, partial differentiation, div, curl and integration of vector functions, tangent and normal components of acceleration.

BOOKS RECOMMENDED:

1. H. Anton, I. Bivens and S. Davis: Calculus,10th Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Shanti Narayan, P. K. Mittal: Differential Calculus, S. Chand, 2014.
3. R. J. T Bell: An elementary Treatise on coordinate geometry, MacMillan and Company Limited, 2005.

BOOKS FOR REFERENCE:

1. James Stewart: Single Variable Calculus, Early Transcendental, 8th edition, Cengage Learning, 2016.
2. G.B. Thomas and R. L. Finney: Calculus, 9th Ed., Pearson Education, Delhi, 2005.
3. M. J. Strauss, G. L. Bradley and K. J. Smith: Calculus, 3rd edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
5. e-Learning Source http://ndl.iitkgp.ac.in ; http://ocw.mit.edu ; http://mathforum.org

Minor (Paper-II) Semester III/IV

INTRODUCTION TO ALGEBRA & NUMBER THEORY

Objectives: To present a systematic introduction to number theory and a basic course on algebra.

Learning Outcomes: After completing the course the student will be able to

CO1: understand the equivalence relations and concept of group with different examples.

CO2: understand the properties of cyclic groups, rings, and integral domain.

CO3: know divisibility and division algorithm and find *gcd* using Euclidean Algorithm.

CO4: solve linear Diophantine equations, find least common multiples, solve linear congruence applying the Chinese remainder theorem.

UNIT- I

Integers and equivalence relations**,** properties of integers, modular arithmetic, mathematical inductions, equivalence relations, Introduction to groups**,** symmetries of a square, the dihedral groups, definitions and examples of groups, elementary properties of groups, subgroups, examples of subgroups.

UNIT-II

Cyclic groups, properties of cyclic groups, classification of subgroups of cyclic groups, definitions and examples of normal subgroups, Introduction to rings, definition and examples of rings, properties of rings, subrings, definition and examples of integral domain and fields.

UNIT-III

Divisibility**,** division algorithms, prime and composite numbers, Fibonacci and Lucas numbers, Fermat numbers, greatest common divisor, Euclidean algorithm.

UNIT-IV

Fundamental theorem of arithmetic, least common multiple, linear Diophantine equations, congruence, linear congruence, Chinese remainder theorem, Wilson's theorem, Fermat little theorem, Euler's theorem.

BOOKS RECOMMENDED:

1. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi, 1999.(IX Edition 2010).
2. Thomas Koshy, Elementary Number Theory with Applications (2nd Edition), Academic Press, 2007.

BOOKS FOR REFERENCE:

1. I. N. Herstein: Topics in Algebra, Wiley Eastern Limited, India, 1975.
2. David M. Burton: Elementary Number Theory (6th Edition), Tata McGraw-Hill Edition, Indian Reprint, 2007.
3. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
4. e-Learning Source http://ndl.iitkgp.ac.in ; http://ocw.mit.edu ; http://mathforum.org.

Minor (Paper-III) Semester-V/VI

REAL ANALYSIS-I

Objective: The objective of the course is to introduce the basics of real number system and the properties of sequence and series of real numbers. The ideas of completeness, least upper bound property, denseness, limit, continuity and uniform continuity will also be introduced. This is one of the core courses essential to start doing mathematics.

Learning Outcomes: On successful completion of this course, students will be able to **CO1:** learn basics of real number system and test countability of a set.

CO2: know on sequence of real numbers and their basic properties.

CO3: test convergence of an infinite series.

CO4: find limit and continuity of functions and test uniform continuity of functions.

UNIT-I

Finite and infinite sets, countable and uncountable sets, examples, algebraic and order Properties of R, unaccountability of R, completeness property of **R,** applications of the supermom property, Intervals, nested interval property, denseness of rationals in R.

UNIT-II

Sequence and their limits, limit theorems, monotone sequences, monotone Convergence theorem, subsequences, divergence criteria, monotone subsequence theorem, Bolzano Weierstrass theorem for sequences, Cauchy sequence, Cauchy's convergence criterion.

UNIT-III

Infinite series, convergence and divergence of infinite series, Cauchy criterion, Tests for convergence: comparison test, limit comparison test, ratio test, Cauchy's nth root test, Raabe's test, integral test, alternating series, Leibniz test, absolute and conditional convergence.

UNIT-V

Limits of functions, limit theorems, some extensions of limit concept, continuous functions and their combinations, continuous functions on intervals, boundedness theorem, maximum minimum theorem, intermediate value theorem, uniform continuity, examples, uniform continuity theorem.

BOOKS RECOMMENDED:

1. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Edn., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. G. Das and S. Pattanayak, *Fundamentals of Mathematical Analysis*, TMH Publishing Co., 30th reprints, 2021.

BOOKS FOR REFERENCE:

3. S. C. Mallik and S. Arora, *Mathematical Analysis*, New Age International Publications.
4. A. Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014.
5. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall, 2001.

6. Gerald G. Bilodeau , Paul R. Thie, G. E. Keough, *An Introduction to Analysis*, Jones & Bartlett, Second Edition, 2010.
7. e-Learning Source http://ndl.iitkgp.ac.in ; http://ocw.mit.edu ; http://mathforum.org 8. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Minor (Paper-IV) Semester VII

LINEAR ALGEBRA

Objective: The objective of this course is to acquaint students with matrix operations, solution of system of equations, vector spaces and linear transformations. In addition, the student will learn about eigenvalues, diagonalization, canonical forms, etc., which has many applications in almost all areas of science and engineering.

Learning Outcomes: After completing the course the student will be able to

CO1: determine basis and the dimension of a finite-dimensional vector space, know the relation between rank and nullity of a linear transformation.

CO2: the relation between matrix and linear transformation.

CO3: to find solution of system of linear equations, compute eigenvalues, eigenvectors of a matrix and linear transformation.

CO4: about orthogonality of vectors and application of it to different form of matrix, introduced to different operators.

UNIT-I

Vector spaces, subspaces, span of a set, more about subspaces, linear dependence, independence, product and quotient space, dimension and basis, linear transformations, range and kernel of a linear map, rank and nullity of linear map.

UNIT-II

Inverse of linear transformation, consequences of rank – nullity theorem, the space L(U, V), composition of linear maps, matrix associated with linear map, linear map associated with matrix, rank and nullity of a matrix, determinant minors and rank of a matrix, transpose of a matrix and special type of matrices, elementary row operations

UNIT-III

System of linear equations, matrix inversion, application of determinant to linear equations, eigenvalues and eigenvectors, similarity of matrices, invariant subspaces, minimal polynomial (eigenvalues and the minimal

polynomial), upper triangular matrices, diagonalizable operators (diagonal matrices, conditions for diagonalizability).

UNIT-IV

Inner product space: inner products and norms, orthonormal bases, orthogonal complements, self-adjoint and normal operators, spectral theorems, isometries, unitary operators, characteristic polynomial, Cayley – Hamilton theorem, Jordan form, trace, quadratic form, application to reduction of quadrics.

BOOKS RECCOMMENDED:

1. V. Krishnamurthy. V.P. Mainra, J. L. Arora, *An introduction to linear algebra*, Affiliated East – West press Pvt. Ltd., New Delhi, 1976.
2. Sheldon Axler, *Linear algebra done right* (Fourth edition), Springer, 2024.

BOOKS FOR REFERENCES:

3. Seymour Lipschutz and Marc Lars Lipson, *Linear Algebra* (Schaum's outlines, Fourth Edition), McGraw Hill, New York, 2009.
4. A. Ramachandra Rao and P. Bhimsankaram, *Linear Algebra (Second* Edition*)*, Hindustan Book Agency, 2000.
5. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra* (Fourth Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
7. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 1999.
8. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
9. e-Learning Source http://ndl.iitkgp.ac.in ; http://ocw.mit.edu ; http://mathforum.org ; https://linear.axler.net; and https://library.oapen.org/handle/20.500.12657/85067

Minor (Paper-V) Semester VIII

MULTIVARIABLE CALCULUS

Objectives: The primary objective of this course is to introduce students, the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables with the geometry and visualization of curves and surfaces. To aware the students about the techniques multiple integrations and higher order derivatives.

Learning Outcomes: After completing the course the student will be able to

CO1: learn the concept of limit, continuity and differentiations of functions of more than one.

CO2: understand the maximization and minimization of multivariable functions with the given constraints on variables.

CO3: learn about inter-relationship amongst the line integral, double, and triple integral formulations.

CO4: familiarize with the Green's, Stokes' and Gauss divergence theorems and their applications.

UNIT-I

Functions of several variables, limit and continuity of functions of two variables: partial differentiation, total differentiability, sufficient condition for differentiability, chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

UNIT-II

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, double integration over rectangular region, double integration over non rectangular region, double integrals in polar co-ordinates.

UNIT-III

Triple integrals, triple integral over a parallelepiped and solid regions, volume by triple integrals, cylindrical and spherical co- ordinates, change of variables in double integrals and triple integrals.

UNIT-IV

Definition of vector field, divergence and curl, line integrals, applications of line integrals: mass and work, fundamental theorem for line integrals, conservative vector fields, independence of path, Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stokes' theorem, the divergence theorem.

BOOKS RECOMMENDED:

1. M. J. Strauss, G. L. Bradley and K. J. Smith: Calculus, 3rd Edition, Dorling Kindersley (India) Pvt. Ltd. Pearson Education, Delhi, 2007.
2. E. Marsden, A. J. Tromba and A. Weinstein: Basic Multivariable Calculus, Springer Student International Edition, Indian reprint, 2005.

BOOK FOR REFERENCES:

1. S. C. Mallik and S. Arora: Mathematical Analysis, New Age International Publications, New Delhi, 2005.
2. Tom Apostol: Mathematical Analysis, Narosa Publishing House, 2002.
3. G. B. Thomas and R. L. Finney: Calculus, 9th Ed., Pearson Education, Delhi, 2005.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
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