SYLLABUS

FOR

M.SC. IN MATHEMATICS

(UNDER NATIONAL CREDIT CURRICULUM FRAMEWORK)

A FOUR SEMESTERS (TWO YEAR) COURSE
WHO WILL PURSUE TWO YEAR M.SC. COURSE

(Effective from the academic session 2026 – 2027 and onwards)

COOCHBEHAR PANCHANAN BARMA UNIVERSITY
COOCHBEHAR, WEST BENGAL

OBJECTIVE:

The duration of the Post Graduate course in Mathematics at Cooch Behar Panchanan Barma University is two years, comprising Semester-I, Semester-II, Semester-III, and Semester-IV, each of six months' duration.

The duration of the Post Graduate course in Mathematics at Cooch Behar Panchanan Barma University is one year for those who want to pursue a one-year M.Sc. course. They have to study Semester-III and Semester-IV, each of six months' duration.

Syllabus for the P.G. course in Mathematics is hereby framed following the guidelines of UGC according to the following schemes and structures. All students admitted to the two-year PG course in Mathematics shall take the courses in Semesters I, II, III, and IV.

SCHEME:

Each semester comprises four papers, with 100 marks allotted to each paper. Twenty percent of the total marks is allotted for Continuous Evaluation, and 5% is allotted for regular attendance. Students have to take three core papers and one Discipline-Centric Elective (DCE) paper in Semester I. Semester II comprises three core papers and one Generic Elective (GE) paper.

The syllabi of Semesters III and Semester IV will be finalized in due course.

All answer scripts of theory examinations will be evaluated by the internal examiners only. The continuous evaluations will be done by the respective subject teachers through class tests, assignments, or a combination of both. The students' answer scripts will be examined by the respective subject teachers of the department. It should be noted that some Discipline Centric Electives, Generic Electives, Coursework papers, and Research papers may be included in the future at the discretion of the department and subject to the approval of the appropriate authority.

31.07.26
Head
Department of Mathematics
Cooch Behar Panchanan Barma University

SEMESTER COURSE STRUCTURE OF M.Sc. in MATHEMATICS

SYLLABUS for SEMESTERS - I, II, III & IV

SEMESTERS	PAPERS	SUBJECTS	MARKS (CREDIT)
Semester I	Core – 1	Advanced Real Analysis	100 (5)
	Core – 2	Advanced Abstract Algebra	100 (5)
	Core – 3	Advanced Ordinary Differential Equations and Special Functions	100 (5)
	DCE	Partial Differential Equations	100 (5)
Semester II	Core – 4	Advanced Complex Analysis	100 (5)
	Core – 5	Functional Analysis	100 (5)
	Core – 6	Classical Mechanics	100 (5)
	GE	Nonlinear Differential Equations (with Practical)	100 (5)
Semester III	Course work paper - 1	To be decided later	100 (5)
	Course work paper - 2	To be decided later	100 (5)
	Course work paper - 3	To be decided later	100 (5)
	Research Paper - 1	To be decided later	100 (5)
Semester IV	Research Paper - 2	To be decided later	100 (5)
	Research Paper - 3	To be decided later	100 (5)
	Research Paper - 4	To be decided later	100 (5)
	Dissertation	To be decided later	100 (5)

31-07-25
Head
Department of Mathematics
Cooch Behar Panchanan Barma University
Cooch Behar

PAPER WISE DISTRIBUTION OF MARKS

Sem	Paper	Theory	Practical/ Seminar	Continuous Evaluation	Attendance	Total	Credit
1st	Core – 1	75	X	20	05	100	05
	Core – 2	75	X	20	05	100	05
	Core – 3	75	X	20	05	100	05
	DCE	75	X	20	05	100	05
2nd	Core – 4	75	X	20	05	100	05
	Core – 5	75	X	20	05	100	05
	Core – 6	75	X	20	05	100	05
	GE (with practical)	50	25	20	05	100	05
3rd	Course work paper - 1					100	05
	Course work paper - 2					100	05
	Course work paper - 3					100	05
	Research Paper – 1 (Group A/ Group B)					100	05
4th	Research Paper - 2					100	05
	Research Paper – 3					100	05
	Research Paper – 4 (Group A/ Group B)					100	05
	Dissertation					100	05
Total						1600	80

SEMESTER I

Duration: 6 Months (Including Examinations)
Total Marks: 400, Total No. of Lectures: (75 Hours per paper)

	Papers	Topics	Marks(Credit)
Semester I	Core – 1	Advanced Real Analysis	100 (5)
	Core – 2	Advanced Abstract Algebra	100 (5)
	Core – 3	Advanced Ordinary Differential Equations and Special Functions	100 (5)
	DCE	Partial Differential Equations	100 (5)

Core - 1

ADVANCED REAL ANALYSIS

(75 Lectures – 75 Hours)

Bounded Variation:

Functions of Bounded Variation and their properties, Riemann- Stieltjes integrals and its properties, Absolutely Continuous Functions. (10 Hours)

The Lebesgue Measure:

Lebesgue Measure: (Lebesgue) Outer measure and measure on R, Measurable sets form an σ-algebra, Borel σ - algebra, Borel sets, measure of open and closed sets, Existence of a non-measurable set, Measure space, Measurable Function and its properties, Borel measurable functions, Concept of Almost Everywhere (a.e.), sets of measure zero, Steinhaus Theorem, Sequence of measurable functions, Egorov's Theorem, Applications of Lusin Theorem.

(35 hours)

The Lebesgue Integral:

Simple and Step Functions, Lebesgue integral of simple and step functions, Lebesgue integral of a bounded function over a set of finite measure, Bounded Convergence Theorem, Lebesgue integral of non-negative function, Fatou's Lemma, Monotone Convergence Theorem. The General Lebesgue integral: Lebesgue Integral of an arbitrary Measurable Function, Lebesgue Integrable functions. Dominated Convergence Theorem. Convergence in Measure. Riemann Integral as Lebesgue Integral. Product measure spaces, Fubini's Theorem (applications only).

(30 Hours)

References:

1. Apostol, T.M., Mathematical Analysis, Narosa Publishing House, 2002.
2. Royden, H.L., Fitzpatrick P.M., Real Analysis, 4th Edition, Pearson.
3. Aliprantis, C.D. &Burkinshaw, O., Principles of Real Analysis, Third Edition, Harcourt Asia Pvt. Ltd., 1998.
4. Jain, P. K., Gupta, V. P. &Jain, P., Lebesgue measure and integration, Third Edition, New Age International.

Further Reading:

1. Halmos, P.R., Measure Theory, Springer, 2007.
2. Rudin, W., Principles of Mathematical Analysis, Tata McGraw Hill, 2001.
3. Rudin, W., Real and Complex Analysis, McGraw-Hill Book Co., 1966.
4. Tao, T., An Introduction to Measure Theory, American Mathematical Society.
5. Kolmogorov, A.N. &Fomin, S.V., Measures, Lebesgue Integrals, and Hilbert Space, Academic Press,New York & London, 1961.
6. Rana, I. K., An introduction to Measure and Integration, Second Edition, Narosa.
7.. Barra, G. D., Measure Theory and Integration, Woodhead Pub.
8. Kingman, J. F. C. & Taylor, S. J., Introduction to Measure and Probability, Cambridge University Press, 1966.
9. Cohn, D. L., Measure Theory, Birkhauser, 2013.
10. Wheeden, R. L. &Zygmund, A., Measure and Integral, Monographs and Textbooks in Pure and Applied Mathematics, 1977.
11.Sohrab, H. H., Basic Real Analysis, Birkhauser, 2003.

Core - 2

ADVANCED ABSTRACT ALGEBRA

(75 Lectures – 75 Hours)

Groups:
Review of basic concepts of Group Theory: Lagrange's Theorem, Cyclic Groups, Permutation Groups and Groups of Symmetry: S_n; A_n; D_n, Conjugacy Classes, Index of a Subgroup, Divisible Abelian Groups. Homomorphism of Groups, Normal Subgroups, Quotient Groups, Isomorphism Theorems, Cayley's Theorem.

Direct Product and Semi-Direct Product of Groups, Fundamental Theorem (Structure Theorem) of Finite Abelian Groups, Cauchy's Theorem, Group Action,Sylow Theorems and their applications, Solvable Groups,Field extension, Galois' theory, Modules. (40 Hours)

Rings:
Ideals and Homomorphisms, Prime and Maximal Ideals, Quotient Field of an Integral Domain, Polynomial and Power Series Rings. Divisibility Theory: Euclidean Domain, Principal Ideal Domain, Unique Factorization Domain, Gauss' Theorem, Irreducibility of polynomials, Chinese remainder theorem, Noetherian ring. (35 Hours)

References:

1. Dummit, D. S., Foote, R. M., Abstract Algebra, Second Edition, John Wiley & Sons, Inc., 1999.
2. Malik, D. S., Mordesen, J. M.& Sen, M. K., Fundamentals of Abstract Algebra, The McGraw-Hill Companies, Inc, 1997.
3. Gallian, J., Contemporary Abstract Algebra, Narosa, 2011.
4. Herstein, I. N., Topics in Algebra, Wiley Eastern Limited.

Further Reading:

1. Roman, S., Fundamentals of Group Theory: An Advanced Approach, Birkhauser, 2012.
2. Sen, M. K., Ghosh, S. Mukhopadhyay, P. & Maity, S. K., Topics in Abstract Algebra, Universities Press.
3. Rotman, J., The Theory of Groups: An Introduction, Allyn and Bacon, Inc., Boston.
4. Rotman, J., A First Course in Abstract Algebra, Prentice Hall, 2005.
5. Pinter, Charles. C., A Book of Abstract Algebra, McGraw Hill, 1982.
6. Fraleigh, J. B., A First Course in Abstract Algebra, Narosa.
7. Jacobson, N., Basic Algebra, I & II, Hindustan Publishing Corporation, India.
8. Hungerford, T. W., Algebra, Springer.
9. Artin, M., Algebra, Prentice Hall of India, 2007.
10. Goldhaber, J. K. & Ehrlich, G., Algebra, The Macmillan Company, Collier-Macmillan Limited, London.
11. Gopalakrishnan, N. S., University Algebra, New Age International, 2005.

Core - 3

ADVANCED ORDINARY DIFFERENTIAL EQUATIONS & SPECIAL FUNCTIONS

(75 Lectures – 75 Hours)

Advanced Ordinary Differential Equations:

Existence and Uniqueness:
Existence theorem, Uniqueness, basic theorems, Ascoli Arzela theorem, Caratheodary's extension theorem. Theorem on convergence of solution of initial value problems. Picard – Lindelöf theorem, Peano's existence theorem. (10 Hours)

Linear Systems:
Introduction, Superposition principle, Properties of linear homogeneous systems, Adjoint systems, Periodic linear systems, Linear equation of order n with constant coefficients, n-th order

linear homogeneous equation with variable coefficients, n-thorderlinear non-homogeneous equation with variable coefficients, Behaviour of the solutions of n-thorder linear homogeneous equations, Linear homogeneous systems. (10 Hours)

Second Order Differential Equations:
Green's function for Ordinary Differential Equations - Application to Boundary Value Problems. Oscillatory equations, Number of zeroes, The Adjoint equation, Lagrange identity, Green's formula, Self adjoint equation, The Strum theory. (15 Hours)

Special Functions:

Singularities:
Fundamental System of Integrals, Singularity of a Linear Differential Equation. Solution in the neighbourhood of a singularity, Regular Integral, Equation of Fuchsian type, Series solution by Frobenius method. (6 Hours)

Legendre Polynomials:
Legendre Functions, Generating Function, Legendre Functions of First & Second kind, Laplace Integral, Orthogonal Properties of Legendre Polynomials, Rodrigue's Formula. Associated Legendre Polynomial. (10 Hours)

Hypergeometric Function:
Hypergeometric Functions, Series Solution near zero, one and infinity. Integral Formula, Confluent Hypergeometric function, Integral representation of Hypergeometric function, Differentiation of Hypergeometric Function. (7 Hours)

Bessel Functions:
Bessel's Functions, Series Solution, Generating Function, Integral Representation of Bessel's Functions, Recurrence Relations, Asymptotic Expansion of Bessel Functions. (7 Hours)

Hermite Polynomial:
Hermite equation and its solution, Generating function, Rodrigue's formula, Recurrence relations, Orthogonal Properties of HermitePolynomials. (5 Hours)

Lagurre polynomial:
Lagurre equation and its solution, Generating function, Recurrence relations, Orthogonal Properties of HermitePolynomials. (5 Hours)

References:

1. Simmons, G. F., Differential Equations, Tata McGraw Hill.
2. Ross, S. L., Differential Equations, John Willey and Sons.
3. Agarwal, Ravi P. & O' Regan D., An Introduction to Ordinary Differential Equations, Springer, 2000.

4. Churchil, R. V. & Brown, J. W., Fourier series and boundary value problems, Fifth Edition, McGraw Hill.
5. Codington, E. A & Levinson, N., Theory of Ordinary Differential Equation, McGraw Hill.

Further Reading:

1. Ince, E.L., Ordinary Differential Equation, Dover.
2. Ghatak, A. K., Goyal, I. C. & Chua, S. J., Mathematical Physics, Laxmi Publications
3. Estham, M. S. P., Theory of Ordinary Differential Equations, Van Nostrand Reinhold Company, 1970.
4. Piaggio, H. T. H., An Elementary Treatise On Differential Equations And Their Applications, G. Bell & Sons, Ltd, 1949.
5. Hartman, P., Ordinary Differential Equations, SIAM, 2002.
6. Zill, D. G. & Cullen, M. R., Differential Equations with Boundary Value Problems, Brooks/Cole, 2009.

Discipline Centric Elective (DCE)

PARTIAL DIFFERENTIAL EQUATIONS

(75 Lectures – 75 Hours)

Fundamental Concepts:

First order non-linear PDE, Characteristics, Second order PDEs and their classifications, Canonical forms, Solution of PDEs with constant coefficients. (6 Hours)

Parabolic Differential Equations:

Formation and solution of Diffusion equations in one and two dimensions, Dirac- Delta function, Separation of variables method, Solution of Diffusion Equation in Cylindrical and spherical coordinates, Examples. (14 Hours)

Hyperbolic Partial Differential Equations:

Formation and solution of one-dimensional wave equation, canonical reduction, Initial ValueProblem, D'Alembert's solution, Vibrating string, Forced Vibration, Initial Value Problem andBoundary Value Problem for two-dimensional wave equation, Periodic solution of one-dimensional wave equation in cylindrical and spherical coordinate systems, vibration of circular membrane, Uniqueness of the solution for the wave equation, Duhamel's Principle, Examples. (15 Hours)

Elliptic Differential Equations:

Derivation of Laplace and Poisson equation, Boundary Value Problem, Separation of Variables,

Dirichlet's Problem and Neumann Problem for a rectangle, Interior and Exterior Dirichlet'sproblems for a circle, Interior Neumann problem for a circle, Solution of Laplace equation in Cylindrical and spherical coordinates, Examples. (15 Hours)

Green's Function:

Green's function for Laplace Equation, methods of Images, Eigen function Method, Green's function for the wave and Diffusion equations. Laplace Transform method: Solution of Diffusion and Wave equation by Laplace Transform. (15 Hours)

Advanced Non-Linear Second-Order PDEs &Monge's Method:

Foundations & Classification, Monge's Subsidiary Equations (The Semi-Linear Case), Integration Strategies & Solution Types, The Generalized Monge-Ampère Equation. (10 Hours)

References:

1. Sneddon, I.N., Elements of Partial Differential Equations, McGraw Hill.

2. Rao, K.S., Introduction to Partial Differential Equations, Prentice Hall.

3. Prasad, P. & Rabindran, R., Partial Differential Equations, New Age International.

Further Reading:

1. Williams, W.E., Partial Differential Equations, Clarendon Press.

2. Miller, K. S., Partial Differential Equations in engineering problems, Dover.

3. Petrovsky, I. G., Lectures on Partial Differential Equations, Dover.

4. Courant ; Hilbert, Methods of Mathematical Physics, Vol-II, Willey-VCH.

5. Amaranath, T., An elementary course in Partial Differential Equations, Narosa

6. Peter V. O'Neil, Advanced Engineering Mathematics, ITP.

7. L. C. Evans, Partial Differential Equations: Second Edition (Graduate Studies in Mathematics) 2nd Edition, American Mathematical Society, 2010.

SEMESTER II

Duration: 6 Months (Including Examinations)
Total Marks: 400, Total No. of Lectures: 75 (75 Hours per paper)

	Papers	Topics	Marks (Credit)
Semester II	Core – 4	Advanced Complex Analysis	100 (5)
	Core – 5	Functional Analysis	100 (5)
	Core – 6	Classical Mechanics	100 (5)
	GE	Nonlinear Differential Equation (with practical)	100 (5)

Core - 4

ADVANCED COMPLEX ANALYSIS

(75 Lectures – 75 Hours)

General Theory:
The difference between Real Analytic functions and C^{∞}-functions over R, Real Analyticity vs. Complex Analyticity, Goursat's Theorem,Morera's Theorem,Liouville's Theorem, Fundamental Theorem of Algebra, Zeros of analytic functions, Poles, Limit point of zeros and poles, Identity Theorem, Weierstrass Convergence Theorem, Maximum Modulus Principle and its applications, Schwarz's Lemma, Index of a closed curve, Conformal maps, Möbius Transformations, Argument Principle, Rouche's Theorem and its applications, Analytic Continuation, Natural Boundary, Function Element, Multiple Valued functions, Branch Points and Branch Cut, Riemann Surfaces. (40 Hours)

Theory of Entire Functions:
The Functions M(r), A(r), Hadamard Theorem on Growth of log M(r), Schwarz Inequality, Borel-Caratheodory Inequality,Growth of an Entire Function, Order and Type and their Representations interms of the Taylor Coefficients, Weierstrass Factor Theorem, The Exponent of Convergence ofZeros,Canonical product, Hadamard Factorization Theorem. (35 Hours)

References:

1. Brown, J. W. & Churchill, R. V., Complex Variables and Applications, Eighth Edition, McGraw-Hill, 2009.
2. Ponnusamy, S., Foundations of Complex Analysis, Narosa, 2008.
3. Conway, J. B., Functions of One Complex Variable, Second Edition, Narosa Publishing House, 1973.

4. Marsden, J. E. & Hoffman, M. J., Basic Complex Analysis, Third Edition, W. H. Freeman and Company, New York, 1999.
5. Yang C. C. and Yi H. X., Uniqueness Theory of Meromorphic Function, Springer Netherlands, 2003
6. Ahlfors, L. V., Complex Analysis, McGraw-Hill, 1979.
7. Markusevich, A. I., Theory of Functions of a Complex Variable, Vol. I, II, III, AMS Chelsea Publishing.
8. Copson, E. T., An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London.
9. Hille, E., Analytic Function Theory (2 vols.), Gonn& Co., 1959.
10. Titchmarsh, E. C., The Theory of Functions, Oxford University Press, London.
11. Hayman, W. K., Meromorphic Functions, Oxford : Clarendon press 1964.
12. Kaplan, W., An Introduction to Analytic Functions, Addison Wesley series in Mathematics, 1966.
13. Levin, B. J., Distribution of zeros of entire functions, Translations of mathematical monographs, Vol. 5, American Mathematical Society.

Core - 5

FUNCTIONAL ANALYSIS

(75 Lectures – 75 Hours)

Banach Spaces:

Normed Linear Spaces and its properties, Banach Spaces, Equivalent Norms, Finite dimensional normed linear spaces and local compactness, Riesz Lemma. Bounded Linear Transformations. Uniform Boundedness Theorem, Open Mapping Theorem, Closed Graph Theorem, Eberlein-Smulian Theorem, Banach-Alaoglu Theorem. Linear Functionals, Necessary and sufficient conditions for Bounded (Continuous) and Unbounded (Discontinuous) Linear functionals in terms of their kernel. Hyperplane, Necessary and sufficient conditions for a subspace to be hyperplane. Applications of Hahn-Banach Theorem, Dual Space, Examples of Reflexive Banach Spaces. L^p-Spaces and their properties. (40 Hours)

Hilbert Spaces:

Real Inner Product Spaces and its Complexification, Cauchy-Schwarz Inequality, Parallelogram law, Pythagorean Theorem, Bessel's Inequality, Gram-Schmidt Orthogonalization Process, Hilbert Spaces, Orthonormal Sets, Complete Orthonormal Sets and Parseval's Identity, Orthogonal Complement and Projections. RieszRepresentationTheorem for Hilbert Spaces, Adjoint of an Operator on a Hilbert Space with examples, Reflexivity of Hilbert Spaces, Definitions and examples of Self-adjoint Operators, Positive Operators, Projection Operators, Normal Operators and Unitary Operators. Introduction to Spectral Properties of Bounded Linear Operators. (35 Hours)

References :

1. Kreyszig, E., Introductory Functional Analysis and its Applications, John Wiley and Sons, New York, 1978.
2. Limaye, B. V., Functional Analysis, Wiley Eastern Ltd, 1981.
3. Lahiri, B. K., Elements of Functional Analysis, World Press.

Further Reading:

1. Brown, A. & Pearcy, C., Introduction to Operator Theory I : Elements of Functional Analysis, Springer-Verlag New York, 1977.
2. Suhubi, E. S., Functional Analysis, Springer, New Delhi, 2009.
3. Aliprantis, C. D. & Burkinshaw, O., Principles of Real Analysis, 3rd Edition, Harcourt Asia Pte Ltd., 1998.
4. Ponnusamy, S., Foundations of Functional Analysis, Narosa, 2011.
5. Goffman, C. & Pedrick, G., First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
6. Bachman, G. & Narici, L., Functional Analysis, Academic Press, 1966.
7. Taylor, A. E., Introduction to Functional Analysis, John Wiley and Sons, New York, 1958.
8. Simmons, G. F., Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.
9. Conway, J. B., A Course in Functional Analysis, Springer Verlag, New York, 1990.
10. Rudin, W., Functional Analysis, Tata McGraw Hill, 1992.

Core - 6

CLASSICAL MECHANICS

(75 Lectures – 75 Hours)

Fundamental Concepts:

Mechanics of a particle, Mechanics of a system of particles, conservation theorem, Constraints, Dynamical systems, Generalized coordinates, Degrees of freedom, Principle of virtual work, D'Alembert's principle,Unilateral and bilateral constraints, Holonomic and non-holonomic system. (8 Hours)

Lagrangian Formulation:

Lagrange's equations of motion from,Lagrangian, Velocity dependent potential, application of Lagrange's equation of motion to a particle andsystem of particles, Gauge function for Lagrangian, Expression of Kinetic energy, Routh's equations, Conservation laws using Lagrange's equations, Invarianceof Lagrange's equations under generalized coordinate transformations. (10 Hours)

Variational Principle:

Variation of functional, Necessary and sufficient conditions for extrema, Euler-Lagrange's equations and its Applications: Geodesic, minimum surface of revolution, Brachistochrone problem and other boundary value problems in ordinary and partial differential equations,Euler-Lagrange's differential equation,Hamilton's variational principle. (15 Hours)

Hamiltonian Formulation:

Hamilton's canonical equations, Hamiltonian, Physical significance of H, applications of Hamilton's equation of motion to a particle and system of particles,Hamilton-Jacobi equations and separation of variables,Phase space, Configuration space and system point. (12 Hours)

Canonical Transformations& Brackets:

Canonical transformation, condition for transformations to be Canonical,Canonical transformation with different generating functions,Lagrange and Poisson brackets and their properties. Canonical equations in terms of Poisson bracket notation, Constant of motion, Relation between infinitesimal transformation and Poisson brackets. (15 Hours)

Mechanics of Rigid Bodies and Theory of Small Oscillations:

Coordinates of rigid body motion, Euler's angle, angular momentum of a rigid body moments and products of inertia, principle axis transformation, Euler's equation of motion of a rigid body, stable and unstable equilibriums. Lagrange's equation of motion for small oscillators, normal coordinates and normal mode frequency of vibrations, free vibration of linear tri-atomic molecules. (15 Hours)

References:

1. Goldstein, H., Classical Mechanics, Dover.
2. Arnold, V. I., Vogtmann, K. & Weinstein, A., Mathematical Methods of Classical Mechanics, Springer (GTM), 1989.
3. Gupta, A. S., Calculus of variations with applications, Prentice Hall of India.

Further Reading:

1. Rana, N. C. and Joag, P. S., Classical Mechanics, Tata McGraw Hill.
2. Louis, N. H.and Finch, J. D., Analytical Mechanics.
3. Ramsay, A. S., Dynamics, Part-II.

Generic Elective
Nonlinear Differential Equations
(with Practical)
(75 Lectures – 75 Hours)

Continuous dynamical systems:
Dynamical systems, Flows, Evolution, Fixed points, Linear stability analysis, Analysis of one dimensional flows. (10 Hours)

Phase plane analysis:
Plane autonomous systems, Phase plane analysis, Local stability of twodimensional linear systems, Linearization and it's limitations, van der Pol oscillator. (8 Hours)

Oscillations:
Linear and non-linear oscillatory systems, Periodic solutions, Poincare theorem, Limit cycles, The Poincare-Bendixson theorem, Lienard system. (8 Hours)

Theory of bifurcation:
Bifurcation, Bifurcation in one and two dimensional systems, Saddle-Node Bifurcation, Pitchfork bifurcation, Transcriticalbifurcation,Hopf bifurcation. (8 Hours)

Discrete dynamical systems:
Maps and Flows, Composition of Maps, Orbits, Phase portraits, Fixed points, Stable and unstable fixed points, Basin of attraction and basin boundary, Periodic points, Periodic cycles, Stability of periodic point and periodic cycle. (8 Hours)

Fractals:
Fractals, Self-similarity and scaling, Self-similar fractals, Construction of Self-similar fractals. (8 Hours)

List of Practical: (25 Hours)

1. Phase Portrait Generation:
Plotting vector fields and phase trajectories for planar nonlinear systems (e.g., Van der Pol oscillator, Lotka-Volterra predator-prey model).

2. Numerical Solution of ODEs:
Implementing Runge-Kutta methods for stiff and non-linear systems of differential equations.

3. Bifurcation:
Visualizing bifurcation diagrams

4. Fractals:
Construction of Self-similar fractals.

References:

1. Jordan, D. W. & Smith, P., Nonlinear Ordinary Differential Equations, OUP.
2. Coddington ,E. A. & Levinson, N., Theory of Ordinary Differential Equations, McGraw Hill.
3. Layek, G. C., An introduction to dynamical systems and chaos, Springer, 2015.
3. Devaney, R. L., An Introduction to Chaotic Dynamical Systems, Westview Press, 2003.
4. Hasselblatt, B. & Katok, A., A first Course in Dynamics, CUP, 2010.
5. Holmgren, R. A. , A first course in discrete dynamical systems, Springer.
6. Alligood, Sauer & York, Chaos, An introduction to dynamical systems, Springer.
7. Falconer, K. , Foundation to fractal geometry, CUP.

31.07.26

Head
Department of Mathematics
Cooch Behar Panchanan Barma University
Cooch Behar