DHARAMPETH M. P. DEO MEMORIAL SCIENCE COLLEGE, NAGPUR

1.2.1 Percentage of programs in which Choice Based Credit System (CBCS)/elective course system has been implemented (10)

Revised SYLLABUS for M. Sc. MATHEMATICS Choice Based Credit System(Semester Pattern)
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Course Study and Scheme of Examination with paper code

Semester I									
Sr. No.	Paper Core/ Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1	Paper -I	1T1	Algebra I	5	5	25	100	125
2	Core -2	Paper -II	1T2	Real Analysis I	5	5	25	100	125
3	Core -3	Paper -III	1T3	Topology I	5	5	25	100	125
4	Core-4	Paper -IV	1T4	Ordinary Differential Equations	5	5	25	100	125
5	Core-5	Paper -V	1T5	Integral Equations	5	5	25	100	125
Semester II									
Sr. No.	Paper Core/Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1	Paper -VI	2T1	Algebra II	5	5	25	100	125
2	Core -2	Paper -VII	2T2	Real Analysis II	5	5	25	100	125
3	Core -3	Paper -VIII	2T3	Topology II	5	5	25	100	125
4	Core-4	Paper -IX	2T4	Differential geometry	5	5	25	100	125
5	Core-5	Paper -X	2T5	Classical Mechanics	5	5	25	100	125

M.Sc. (Mathematics) Under CBCS
Course Study and Scheme of Examination with paper code

Semester III									
Sr. No.	Paper Core/Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1 (Compulsory paper)	Paper -XI	3T1	Complex Analysis	5	5	25	100	125
2	Core -2 (Compulsory paper)	Paper -XII	3T2	Functional Analysis	5	5	25	100	125
3	Core -3 (Compulsory paper)	Paper - XIII	3T3	Mathematical Method	5	5	25	100	125
4	Core Elective (Opt any one)	Paper – XIV (Opt any one)	3T4	(i) Fluid Dynamics-I (ii) General Relativity (iii) Measure and Integration Theory (New) (iv) Number Theory (v) Algebraic Topology- I	5	5	25	100	125
5	Foundation Paper	Paper - XV	3T5	Elementary Mathematics -I	5	5	25	100	125
OR	Subject Centric	Paper - XV	3T5	Operation Research -I	5	5	25	100	125

M.Sc. (Mathematics) Under CBCS
Course Study and Scheme of Examination with paper code

Semester IV									
Sr. No.	Paper Core/Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1 (Compulsorypaper)	Paper -XVI	4T1	Dynamical Systems	5	5	25	100	125
2	Core -2 (Compulsorypaper)	Paper -XVII	4T2	Partial Differential Equations	5	5	25	100	125
3	Core -3 (Compulsorypaper)	Paper - XVIII	4T3	Advance Numerical Methods	5	5	25	100	125
4	Core Elective (Opt any one)	Paper –XIX (Opt any one)	4T4	(i) Fluid Dynamics II (ii) Cosmology (iii) Cryptography (iv)Operator theory (v)Algebraic Topology-II	5	5	25	100	125
5	Foundation Paper	Paper -XX	4T5	Elementary Discrete Mathematics -I	5	5	25	100	125
OR	Subject Centric	Paper -XX	4T5	Operation Research -II	5	5	25	100	125

Detailed Syllabus

M. Sc. Mathematics

Semester-I

Paper – I (Code: 1T1)

Algebra -I

Unit I:

Permutation Group. Normal subgroups, Quotient groups Dihedral group. Commutator group. Isomorphism Theorems. Automorphisms. Characteristic subgroup. Conjugacy and G-Sets, - Cyclic Decomposition - Alternating group An – Simplicity of An.

Unit II:

Normal Series. Solvable groups. Nilpotent groups. Cyclic decomposition of permutation group. Alternating groups. Simplicity of An.

Unit III:

Direct product, semi-direct product of groups, initely generated abelian groups - Invariants of a finite abelian group, Sylows theorems. Groups of order 2 p and pq.

Unit IV:

Ideals and Homomorphisms. Sum and direct sum of ideals. Maximal and prime ideals. Nilpotent and Nil ideals. Modules. Submodules. Direct sums. R-homomorphisms and quotient modules. Completely reducible modules. Free modules.

Text Book:

Basic Abstract Algebra :Bhattacharya, Jain, and Nagpal ,Second Edition,
Cambridge University Press.

Reference Books:

1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.

2. Abstract Algebra: David S.Dummit and Richard M. Foote, John Wiley.

M. Sc. Mathematics

Semester-I

Paper – II (Code: 1T2)

Real Analysis-I

Unit I:

Uniform convergence. Uniform convergence and continuity. Uniform convergence and integration. Uniform convergence and differentiation. Equicontinuous families of functions. The Stone-Weierstrass theorem.

Unit II:

Differentiation. The Contraction Principle. The Inverse Function Theorem. The Implicit Function Theorem. The Rank Theorem. Partitions of unity.

Unit III:

The space of tangent vectors at a point of Rn. Another definition of Ta (Rn). Vector fields on open subsets of Rn. Topological manifolds. Differentiable manifolds. Real Projective space. Grassman manifolds. Differentiable functions and mappings.

Unit IV:

Rank of a mapping. Immersion. Sub manifolds. Lie groups. Examples of Lie groups.

Text Books:

1. Principles of Mathematical Analysis (Third Edition): Walter Rudin Mc GRAW – HILL Book Company.

2. An Introduction to Differentiable Manifolds and Riemannian Geometry: W. Boothby, Academic Press, 1975.

Reference Books:

1. Methods of Real Analysis: R. R. Goldberg, John Wiley.

2. Calculus of Several Variables: C Goffman, Harper and Row.

M. Sc. Mathematics

Semester-I

Paper – III (Code: 1T3)

Topology-I

Unit I:

Countable and Uncountable sets. Examples and related Theorems. Cardinal Numbers and related Theorems. Topological Spaces and Examples.

Unit II:

Open sets and Limit points, Derived Sets. Closed sets and closure operators. Interior, Exterior and boundary operators. Neighbourhoods, bases and relative topologies.

Unit III:

Connected sets and components. Compact and countably compact spaces. Continuous functions and homeomorphisms, Arc wise connectivity.

Unit IV:

To and T1-spaces, T2-spaces and sequences. Axioms of countability. Separability. Regular and normal spaces.

Text Book:

Foundations of General Topology: W.J. Pervin, Academic press, 1964.

Reference Books:

1. Topology: J.R. Munkres, (second edition), Prentice Hall of India, 2002.

2.Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill 1963.

3. General Topology: J.L. Kelley, Van Nostrand, 1995.

4. Introduction to general Topology: K.D. Joshi, Wiley Eastern Ltd. 1983

M. Sc. Mathematics

Semester-I

Paper – IV (Code: 1T4)

Ordinary Differential Equations

Course Outcomes: The aim of this course is to study basic notions in Differential Equations and use the results in developing advanced mathematics. After completion of this course students will able to solve application problems modeled by linear differential equations and will able to use power series methods to solve differential equations about ordinary points and regular singular points.

Unit I:

Linear Equations with variable coefficients: Initial value problems for the homogeneous equations. Solutions of the homogeneous equations, The Wronskian and linear independence, Reduction of the order of a homogeneous equation, The non-homogenous equations, Homogeneous equations with analytic coefficients, The Legendre equations.

Unit - II:

Linear Equations with regular singular points: The Euler equations, Second order equations with regular singular points, The Bessel equation, Regular singular points at infinity.

Unit III:

Existence and uniqueness of solutions to first order equations: The method of successive approximations, The Lipschitz condition of the successive approximation. Convergence of the successive approximation, Non-local existence of solutions, Approximations to solutions and uniqueness of solutions.

Unit IV:

Existence and Uniqueness of Solutions to System of first order ordinary differential equations: An example- Central forces and planetary motion, Some special equations, Systems as vector equations , Existence and uniqueness of solutions to systems, Existence and uniqueness for linear systems, Green's function, Sturm Liouville theory.

Text Book:

1) E.A.Coddington: An introduction to ordinary differential equations (2012), Prentice Hall of India Pvt.Ltd. New Delhi.

2) G. Birkoff and G.G.Rota: Ordinary Differential equations, John Willey and Sons

3) Mark Pinsky: Partial differential equations and boundary-value problems with applications, AMS, 3rd edition(2011).

Reference books:

1. G.F. Simmons Differential Equations with Applications and Historical note, MeGraw Hill, Inc. New York. (1972)

2. E.A. Coddington and Levinson: Theory of ordinary differential equations McGraw Hill, New York(1955) 3.E.D. Rainvills :Elementary differential equations, The Macmillan company, New York. (1964)

M. Sc. Mathematics

Semester-I

Paper – V (Code: 1T5)

Integral Equations

Unit 1:

Preliminary concepts of integral equations. Some problems which give rise to integral equations. Conversion of ordinary differential equations into integral equations. Classification of linear integral equations. Integro-differential equations.

Unit 2:

Fredholm equations. Degenerate kernels. Hermitian and symmetric kernels. The Hilbert- Schmidt theorem. Hermitization and symmetrization of kernels. Solutions of integral equations with Green's function type kernels.

Unit 3:

Types of Voltera equations. Resolvent kernel of Voltera equations, Convolution type kernels. Some miscellaneous types of Voltera equations. Non-linear Voltera equations. Fourier integral equations. Laplace integral equations.

Unit 4:

Hilbert transform. Finite Hilbert transforms. Miscellaneous integral transforms. Approximate methods of solutions for linear integral equations. Approximate evaluation of Eigen values and Eigen functions.

Text Book:

Integral Equations: A short course: L. G. Chambers: International text book company Ltd, 1976.

Reference books:

1. Integral equations by Shanti Swaroop, Shiv Raj Singh
2. Linear integral equation, Theory and techniques, Academic press, New York 1971
3. R.P. Kanwal, Linear Integral Equation, Theory and Techniques, Academic Press, N.Y. (1971).
4. S.G. Mikhlin, Linear Integral Equations, Hindustan Book Agency, (1960).
5. A.M. Viazwaz, A First Course in Integral Equations, World Scientific (1997).
6. L.I.G. Chambers, Integral Equation: A Short Course, International Text Book Company Ltd. (1976).
7. Larry Andrews, Bhimsen Shiramoggo, Integral Transform for Engineers, Prentice Hall of India (2003).
8. Integral equations and boundary value problems by M. D. Raisinghania, S. Chand publication

M. Sc. Mathematics

Semester-II

Paper – VI (Code: 2T1)

Algebra-II

Unit 1:

Unique factorization domains. Principal Ideal domains. Euclidean domains. Polynomial rings over unique factorization domains.

Unit 2:

Irreducible polynomials and Eisenstein criterion. Adjunction of roots. Algebraic extensions. Algebraically closed fields. Splitting fields. Normal extensions. Splitting fields, multiple roots.

Unit 3:

Finite fields. Separable extensions. Automorphism groups, and fixed fields. Fundamental theorem of Galois theory. Fundamental theorem of algebra.

Unit 4:

Roots of unity and Cyclotomic polynomials. Cyclic extensions. Polynomials solvable by radicals. Ruler and compass constructions.

Text Book:

Basic Abstract Algebra: Bhattacharya, Jain, Nagpaul; Second Edition, Cambridge University Press.

Reference Books:

1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.

2. Abstract Algebra, David S.Dummit and Richard M.Foote, John Wiley.

M. Sc. Mathematics

Semester-II

Paper – VII (Code: 2T2)

Real Analysis -II

Unit 1:

Outer measure.Measurable sets and Lebesgue measure. Anon-measurable set, Measurable functions, Littlewood's three principles.

Unit 2:

The Riemann integral. Lebesgue integral of a bounded function over a set of finite measure. Integral of a non-negative function. General Lebesgue integral. Convergence in measure. Differentiation of monotone functions. Functions of bounded variation. Differentiation of an integral.

Unit 3:

Absolute continuity.Convex functions. Lp-spaces. Holder and Minkowski inequality. Riesz-Fischer theorem. Approximation in Lp. Bounded linear functionals on Lp-spaces.

Unit 4:

Compact metric spaces. Baire category theorem. Arzela Ascoli theorem.
Locally compact spaces. Sigma compact spaces.

Text Book :

Real Analysis, H.L. Royden, Third edition, Prentice Hall, 1988.

Reference Books :

1. Measure theory and Integration, G. de Barra Wiley Eastern Limited, 1981.

2. An introduction to Measure & Integration, Inder K. Rana, Narosa Publishing House

M. Sc. Mathematics

Semester-II

Paper – VIII (Code: 2T3)

Topology-II

Objectives : To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.

Unit I :

Continuous Functions: Continuous functions - the product topology - The metric topology. Chapter 2 : Sections 18 to 21 [Omit Section 22]

Unit II:

Connectedness: Connected spaces - connected subspaces of the Real line - Components and local connectedness. [Chapter 3 : Sections 23 to 25]

Unit III:

Compactness: Compact spaces - compact subspaces of the Real line - Limit Point Compactness - Local Compactness. [Chapter 3 : Sections 26 to 29]

Unit IV:

Countability And Separation Axiom: The Countability Axioms - The separation Axioms - Normal spaces - The Urysohn Lemma - The Urysohn metrization Theorem - The Tietz extension theorem. [Chapter 4 : Sections 30 to 35]

Text Book:

James R. Munkres, Topology (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)

Reference Books

1. J. Dugundji , Topology , Prentice Hall of India, New Delhi, 1975.

2. George F.Sinmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963

3. J.L. Kelly, General Topology, Van Nostrand, Reinhold Co., New York

4. L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.

5. S.Willard, General Topology, Addison - Wesley, Mass., 1970

M. Sc. Mathematics

Semester-II

Paper – IX (Code: 2T4)

Differential Geometry

Course outcome: The course introduces the fundamentals of differential geometry primarily by focusing on the theory of curves and surfaces in three space. The theory of curves studies global properties of curves such as the four vertex theorem. The theory of surfaces introduces the fundamental quadratic forms of a surface, intrinsic and extrinsic geometry of surfaces, and the Gauss-Bonnet theorem.

Unit I:

Definition of surface. Curves on a surface. Surfaces of revolution. Helicoids. Metric. Direction coefficients. Families of curves. Isometric correspondence. Intrinsic properties. Geodesics. Canonical geodesic equations.

Unit II:

Normal property of geodesics. Existence theorems. Geodesic parallels. Geodesic curvature. Gauss Bonnet theorem. Gaussian curvature. Surfaces of constant curvature. Conformal mapping. Geodesic mapping.

Unit III:

Second fundamental form. Principal curvatures. Lines of curvature. Developable. Developable associated with space curves. Developable associated with curves on surfaces. Minimal surfaces and ruled surfaces. Fundamental equations of Surface theory. Parallel surfaces.

Unit IV:

Compact surfaces whose points are umbilics. Hilbert's lemma. Compact surfaces of constant Gaussian or mean curvature. Complete surfaces. Characterisation of complete surfaces. Hilbert's theorem. Conjugate points on geodesics. Intrinsically defined surfaces. Triangulation. Two dimensional Riemannian manifolds. Problem of metrization. Problem of continuation.

Text Book:

An introduction to Differential Geometry: T.J. Wilmore; Oxford University Press

References:

1. W . Klingenberg (Springer), A course in Differential Geometry
2. Geometry of curves and surfaces: do Carmo, Academic Press.
3. Weatherburn, C. Riemannian Geometry and Tensor Calculus
4. D. Somasundaram, Differential Geometry a first course, Narosa Publishing House, 2008

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Semester-II

Paper – X (Code: 2T5)

Classical Mechanics

Unit I:

Variational principle and Lagranges Equations : Hamilton's principle, some techniques of the calculus of variations. Derivation of Lagrange' s Equations from Hamilton's Principle. Extension of principle to nonholonomic systems. Conservation theorems and symmetry properties.

Unit II: Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, Routh's equations, Derivation of Hamilton's equations from a variational principle, the principle of least action.

Unit III:

Canonical transformations : The equations of Canonical transformation, examples of canonical transformations. Symmetric approach to Canonical Transformation, Poisson's bracket & other canonical invariants.

Unit IV:

Equations of motion. Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, the angular momentum poisson bracket relations, Hamilton-Jacobi theory for Hamilton's principle, and Hamilton-Jacobi theory for characteristic functions.

Text Book:

H. Goldstein, Classical Mechanics, Second edition, Narosa Publishing House, New Delhi

References:

1. T.M. Karade, G.S.Khadekar, Lectures on Advanced Mechanics, Sonu-Nilu publication

2. A.S.Ramsey Dynamics Part-II, the English Language Book Society and Cambridge University Press.

3. Gupta, Kumar and Sharma, Classical Mechanics

4. I.D. Landau and E.M. Lifchitz, Vol. I third edition, Perguman press, New Delhi

5. N. C. Rana & P .S. Joag ,Classical Mechanics ,Tata Mc Graw Hill

6. L. M. Katkar, Classical Mechanics(Mathematics), Shivaji University Kolhapur, 2007

M. Sc. Mathematics

Semester-III

Paper – XI (Code: 3T1)

Complex Analysis

Unit I:

Impossibility of ordering Complex numbers. Extended complex plane and stereographic projection. Elementary properties and examples of analytic Functions: Power series, analytic functions.

Unit II:

Analytic functions as mappings, Mobius transformations. Power series representation of analytic functions, zeros of an analytic function, index of a closed curve.

Unit III:

Cauchy's theorem and integral formula, the homotopic version of cauchy's theorem and simple connectivity, counting zeros; the open mapping theorem, Goursat's theorem, Classification of singularities, residues, the argument principle.

Unit IV:

The maximum principle. Schwarz's lemma. convex functions and Hadamards three circles theorem. Phragmen-Lindel of theorem.

Text Book:

Functions of one complex variable: John B. Conway, Second edition, Springer international Student Edition.

Reference Book:

Complex Analysis, L.V. Ahlfors. Mc-Graw Hill, 1966.

M. Sc. Mathematics

Semester-III

Paper – XII (Code: 3T2)

Functional Analysis

Unit I:

Normed spaces, Banach spaces, Further properties of normed spaces. Finite dimensional normed spaces and subspaces. Compactness and finite dimension. Bounded and continuous linear operators.

Unit II:

Linear functionals. Normed spaces of operators. Dual spaces. Inner product space. Hilbert space. Further properties of inner product spaces. Orthogonal complements and direct sums. Orthonormal sets and sequences. Total orthonormal sets and sequences.

Unit III:

Representation of functionals on Hilbert spaces. Hilbert adjoint operators, self adjoint, unitary and normal operators. Hahn-Banach Theorem, Hahn-Banach Theorem for complex vector spaces and normed spaces. Reflexive spaces.

Unit IV:

Category theorem, Uniform boundedness theorem, strong and weak convergence, Convergence of sequences of operators and functionals. Open mapping theorem, Closed linear operators and closed graph theorem.

Text Book:

Introductory Functional Analysis with Applications by E. Kreyszig, John Wiley and Sons.

Reference Books:

1. Introduction to Functional Analysis by A.E. Taylor and D.C. Lay, John Wiley and Sons.

2. Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill

M. Sc. Mathematics

Semester-III

Paper – XIII (Code: 3T3)

Mathematical Methods

Unit I:

Fourier integral theorem. Fourier transforms. Fourier cosine and sine transform. Fourier transforms of derivatives. Fourier transforms of some simple functions. The Fourier transforms of rational functions. The convolution integral. Parseval's theorem for Cosine and Sine transforms. Multiple Fourier transform.

Unit II:

The solution of integral equations of convolution type. Solution of partial differential equation by means of Fourier transform (Laplace's Equation, Diffusion Equation, Vibration Problems) Fourier transform in Statistics. Fourier transforms in Quantum Mechanics.

Unit III:

Finite Fourier transform. Finite Sturm-Liouville transforms. Generalized finite Fourier transform.

Unit IV:

Finite Hankel transform. Finite Legendre transform. Finite Mellin transform.

Text Book:

The use of integral transforms: I N. Sneddon, Tata Mc Graw Hill Publishing Company Ltd.

References Books:

Modern Mathematics for Engineers: Edwin F Beckenbach, Second series, Mc Graw Hill Book Company.

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Semester-III

Core Elective*

Paper – XIV (Code: 3T4)

(i) Fluid Dynamics-I

Unit I:

Real fluids and ideal fluids. Velocity of a fluid at a point. Stream lines and path lines. Steady and unsteady flows. Velocity potential. Velocity vector. Local and particle rate of change. Equation of continuity. Acceleration of a fluid. Condition at a rigid boundary. General analysis of fluid motion. Euler's equation of motion. Bernoulli's equation. Worked examples. Discussion of the case of steady motion under conservative body forces. Some further aspects of vortex motion.

Unit II:

Sources, sinks and doublets. Images in a rigid infinite plane. Images in solid spheres. Axisymmetric flows. Stokes' stream function. The complex potential for two-dimensional irrotational, incompressible flow. Complex velocity potential for standard two dimensional flow. Uniform stream. Line source and line sink. Line doublets. Line vortices. Two dimensional image systems. The Milne-Thomson circle theorem. Circle Theorem. Some applications of circle theorem. Extension of circle theorem. The theorem of Blasius.

Unit III:

The equations of state of a substance, the first law of thermodynamics, internal energy of a gas, functions of state, entropy, Maxwell's thermodynamic relation, Isothermal Adiabatic and Isentropic processes. Compressibility effects in real fluids, the elements of wave motion. One dimensional wave equation, wave equation in two and three dimensions, spherical waves, progressive and stationary waves.

Unit IV:

The speed of sound in a gas, equation of motion of a gas. Sonic, subsonic, supersonic flows; isentropic gas flow. Reservoir discharge through a channel of varying section, investigation of maximum mass flow through a nozzle, shock waves, formation of shock waves, elementary analysis of normal shock waves.

Text Book:

F. Chorlton, Text book of Fluid Dynamics, CBS Publishers, Delhi 1985.

Reference Books:

1. G.K. Batchelor, An Introduction to fluid Mechanics, Foundation Books, New Delhi 1994.

2. M.D. Raisinghania, fluid Mechanics, S. Chand and Company, Delhi.

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Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(ii) General Relativity

Unit I:

Tensor Algebra, Riemannian geometry, Curvature Tensor: Covariant Curvature tensor, Ricci tensor, Einstein Tensor, The Bianchi identity.

Unit II:

The principle of covariance, The principle of equivalence, Geodesic principle, Newton's equations of motion as an approximation of geodesic equations, Poisson's equations as an approximation to Einstein field equations.

Unit III:

Gravitational field equations in free space, Exterior Schwarzchild's solution and its isotropic form, Birkhoff's theorem, Schwarzchild singularity, planetary orbit, Advance of Perihelion of a planet, Bending of light rays in the gravitational filed, Gravitational Red shift in the spectral lines.

Unit IV:

Newtonian Incompressible star, The pressure contribution mass of static, spherically symmetric System, The Tolman-Oppenheimer-Volkoff Equation, Schwarzchild's Interior solution,

Text Book:

(i) Introduction to General Relativity: Ronald Adler, Maurice Bezin and Manamen Schiffer, McGraw-Hill Kogakusha Ltd.

(ii) Lecture Notes on General Theory of Relativity, **Øyvind Gron** (Oyvind Gron) , Springer publication

Unit 4 : Chapter 10 , articles [10.1, 10.2,10.3, 10.4]

References Books:

1. Introduction to theory of relativity, Rosser W.G.V., ELBS(1972).

2. Lecture on General Relativity, T M Karade, G S Khadekar and Maya S Bendre, Sonu Nilu Publication (2004)

3. Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press (2003).

4. The Classical Theory of Fields By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press (1978).

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Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(iii) Measure and Integration Theory

Unit-I:

Lebesgue outer measure, measurable sets, Regularity,Measurable functions, Borel and **Lesbesgue measurability.**

Unit II:

Integration of Non-negative function, the general integral, integration of series, Riemann and Lebesgue integrals.

Unit-III:

The Four derivatives, continuous non-differentiable functions, functions of bounded variation, Lebesgue differentiation theorem, differentiation and integration.

Unit-IV: Measures and outer measures, Extension of a measure, : The uniqueness of Extension, completion of a measure, measure spaces, integration with respect to a measure. spaces, convex functions, Jensen's inequality

Text Book:

Bartle R.G ., The Elements of Integration, John Wiley & Sons, Inc.,New York, 1966.

References :

1. Bartle R.G ., The Elements of Integration, John Wiley & Sons, Inc.,New York, 1966.
2. G .de Barra, Measure Theory and Integration. Wiley Eastern Limited,1981.
3. Halmos P .R. Measure Theory, Van Nostrand Princeton, 1950.
4. Hawkins T. G., Lebesgue' s Theory of Integration, its origins and Development, Chelsea, New York, 1979.
5. Inder K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
6. Karade T .M., Salunke J.N., Lectures on Advanced Real Analysis, Sonu Nilu Publication, Nagpur, 2004.
7. Royden H.L., Real Analysis, Macmillan Pub. Co. Inc., 4th Edition, New York, 1993
8. P.K. Jain and V.K.Gupta, Leabegue Measure and integration, June-2010

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Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(iv) Number Theory

Unit I:

Introduction, The Mobius function u(n), The Euler totient function φ(n), A relation connecting φ and μ. A product formula for φ (n),The Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius Inversions formula. The Mangoldt function π(n), Multiplicative functions. Multiplicative functions and Dirichlet multiplication, The inverse of a completely multiplicative function, Liouville's function (n), The divisor function (n). Generalised convolutions.

Unit II:

Introduction, The big oh notation Asymptotic equality of functions, Euler's summation formula, some elementary asymptotic formulas, the average order of d(n), the average order of divisor functions (n), the average order of φ(n), An application to the distribution of lattice points visible from the origin. The average order of μ(n) and π(n), The partial sums of a Dirichlet product, Applications to μ(n) and π(n), Another identity for the partial sums of a Dirichlet product.

Unit III:

Introduction, Chebyshev's functions Ψ(x)and v(x). Relations connecting Ψ (x)and v(x), some equivalent forms of the prime number theorem, Inequlities of π(n) and Pn Shapiro's Tauberian theorem. Application of Shapiro's theorem. An asymptotic formulae for the partial sums $\sum (1/p)$.

Unit-IV:

Definition and basic properties of congruences. Residue classes and complete residue systems. Linear congruences. Reduced residue systems and Euler - Format theorem, Polynomial congruences modulo p, Lagrange's theorem. Simultaneous linear congruences, the Chinese remainder theorem. Applications of the Chinese remainder theorem. Polynomial congruences with prime power moduli.

Sections: 2.2 to 2.14 3.1 to 3.12 4.1 to 4.9 5.1 to 5.9

Text Book:

Introduction to analytic number theory - by Tom M-Apostol, Narosa Publishing House, New Delhi.

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Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(v) Algebraic Topology- I

Unit I:

The Elements of Homotopy theory: Introduction. Homotopic mappings. Essential and inessential mappings. Homotopically equivalent spaces. Fundamental group. Knots and related embedding problems. Higher homotopy groups. Covering spaces.

Unit II:

Polytopes and triangulated spaces: E^n as a vector space over E^1.Barycentric coordinates. Geometrical complexes and polytopes. Barycentric subdivision. Simplicial mappings and simplicial approximation theorem.

Unit III:

Abstract simplicial complexes. Embedding theorem for polytopes. Simplicial homology theory: Introduction. Oriented complexes. Incidence numbers. Chains, cycles and groups.

Unit IV:

Decomposition theorem for abelian groups. Betti numbers and torsion coefficients. Zero dimensional homology groups. Universal coefficients. Euler Poincare formula. Universal coefficients.

Text Book:

Topology : J.G. Hocking and G.S. Young : Addison Wesley, 1961

Reference Books :

1. Topology : J.R.Munkres, Prentice Hall, Second Edition, 2000

2. Basic Concepts of Algebraic Topology : Fred H.Croom , Springer Verlag 1978.

NOTE*: Candidates can choose any one paper from Core elective.

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Semester-III

PAPER XV: FOUNDATION (For Students other than Mathematics)
Paper – XV (Code: 3T5)

MATHEMATICS-I

Elementary Mathematics-I

Unit I:

Differentiation: Derivative of a constant function, derivative of trigonometric functions, derivative of inverse trigonometric functions, derivative of hyperbolic function, derivation of parametrically defined functions, logarithmic differentiation.

Unit II:

Integration: Methods of integration, integration by substitution, three important forms of integrals, six important integrals, integration by parts, definite integrals, reduction formulae.

Unit III:

Matrices & Determinant: Transpose of matrix, orthogonal matrices, unitary matrices, Hermitian and Skew-Hermitian matrices, idempotent matrix, Involutory matrix, minors and factors, properties of determinants, determinants-general treatment, symmetric & Skew-symmetric determinant.

Unit IV:

Complex Number: Definition, conjugate, modulus and argument, Algebra of complex number (Addition, Subtraction, Multiplication and Division), power and square root of complex number, properties of complex number, Argand diagram, solution of quadratic equation in complex number system.

Text Books:

1. Differential Calculus by Shanti Narayan (Unit 1 & Unit 2)

2. An Introduction to Matrices by S.C. Gupta (Unit 3 & Unit 4)

M. Sc. Mathematics

Semester-III

CORE SUBJECT CENTRIC (Only Students of Mathematics)

Paper – XV (Code: 3T5)

Operational Research-I

Course Outcomes: Students would be able to:

CO1 Identify and develop operations research model describing a real life problem.

CO2 Understand the mathematical tools that are needed to solve various optimization

problems.

CO3 Solve various linear programming, transportation, assignment, queuing, inventory and game problems related to real life.

Unit I:

Operations Research: Origin, Definition and scope. Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two-phase methods, Degeneracy, Duality in linear programming.

Unit II:

Transportation Problems: Basic feasible solutions, Optimum solution by steppingstone and modified distribution methods, Unbalanced and degenerate problems, Transhipment problem. Assignment problems: Hungarian method, Unbalanced problem, Case of maximization, Travelling salesman and crew assignment problems.

Unit III:

Concepts of stochastic processes, Poisson process, Birth-death process, Queuing models: Basic components of a queuing system, Steady-state solution of Markovian queuing models with single and multiple servers (M/M/1. M/M/C, M/M/1/k, M/MC/k).

Unit IV:

Inventory control models: Economic order quantity (EOQ) model with uniform demand, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks. Deterministic inventory models including price breaks. Multi-item inventory model with constraints.

Text book:

Operations Research: Kanti Swarup P.K. Gupta and Man Mohan: Sultan Chand and Sons New Delhi.

Recommended Books:

1. H. A. Taha, Operations Research – An Introduction, Prentice-Hall, 1997.

2. J. K. Sharma, Operations Research: Theory and Applications, Macmillan, 1997

3. S. D. Sharma, H. Sharma, Operations Research: Theory, Methods and Applications, Kedar Nath Ram Nath, 1972

4. S. S. Rao, Optimization-Theory and Applications, Wiley Eastern Ltd., 1977.

5. F. S. Hillier, G. J. Lieberman, Introduction to Operations Research, McGraw-Hill, 2001

6. M. S. Bazaraa, H. D. Sherali, C. M. Shetty, Nonlinear Programming-Theory and Algorithms, Wiley-Interscience, 2006

7. A. K. Bhunia and L. Sahoo, Advanced Operations Research, Asian Books Private Limited, New Delhi, 2011.

8. M. Aokie, Introduction to Optimization Techniques: Fundamentals and Applications of Nonlinear Programming, The Macmillan Company, 1971.

M. Sc. Mathematics

Semester-IV

Paper – XVI (Code: 4T1)

Dynamical Systems

Unit I:

Dynamical systems and vector fields. The fundamental theorem. Existence and uniqueness. Continuity of solutions in initial conditions. On extending solutions. Global solutions. The flow of a differential equation.

Unit II:

Nonlinear sinks. Stability. Liapunov function. Gradient systems. Gradients and inner products.

Unit III:

Limit sets, local sections and flow boxes, monotone sequences in planar dynamical systems. The Poincare Bendixson theorem, Applications of Poincare-Bendixson theorem; one species, predator and prey, competing species.

Unit IV:

Asymptotic stability of closed orbits, discrete dynamical systems. Stability and closed orbits. Non Autonomous equations and differentiability of flows. Persistence of equilibria, persistence of closed orbits. Structural stability.

Text Book:

Differential equations, dynamical systems & linear algebra: M.W. Hirsch & S. Smale, Academic Press, 1975.

Reference Book:

Dynamical systems: V.I. Arnold, Springer Verlag, 1992.

M. Sc. Mathematics

Semester-IV

Paper – XVII (Code: 4T2)

Partial Differential Equations

Course Outcomes: Upon successful completion of this course, the student will be able to:

i. Classify partial differential equations and transform into canonical form

ii. Solve linear partial differential equations of both first and second order.

iii. Solve boundary value problems for Laplace's equation, the heat equation, the wave equation by separation of variables, in Cartesian, polar, spherical and cylindrical coordinates.

Unit I:

Curves and surfaces, First order Partial Differential Equations, classification of first order partial differential equations, classifications of Integrals, Linear equations of first order. Pfaffian differential equations, Criteria of Integrability of a Pfaffian differential equation. Compatible systems of first order partial differential equations.

Unit II:

Charpits method, Jacobi method of solving partial differential equations, Integral surfaces through a given curve for a linear partial differential equations: Cauchy Problem, Quasi Linear Equations: Geometry of Solutions, Non-linear First Order partial differential equations.

Unit III:

Second order Partial Differential Equations, Classification of second order partial differential equation, Vibration of an infinite string (both ends are not fixed), Physical Meaning of the solution of the wave equation. Vibration of an semi infinite string, Vibration of a string of finite length:(Method of separation of variables), Uniqueness of solution of wave equation. Heat conduction Problems with finite rod and infinite rod.

Unit IV:

Laplace equation, Boundary Value Problems: Dirichlets problems and Neumann problems, Maximum and minimum principles . Dirichlet Problems and Neumann problems for a circle, for a rectangle and for a upper half plane, Families to equipotential surfaces, Solution of Laplace equation, Laplace equation in polar form,

Laplace equation in spherical polar coordinates. Kelvin’s inversion theorem, Stability theorem, Duhamel's Principle.

Text Book:

1. T. Amarnath: An elementary course in Partial differential equations, 2nd edition, Narosa publishing House (2012).

Reference Books:

1. Mark Pinsky: Partial differential equations and boundary-value problems with applications, AMS,3rd edition(2011).

2. I. N. Sneddon: Elements of Partial Differential Equations, McGraw Hill Int.

3. Fritz John: Partial Differential Equations, Springer(1952).

M. Sc. Mathematics

Semester-IV

Paper – XVIII (Code: 4T3)

Advance Numerical Methods

Unit I:

Simple enclosure methods, Secant method, Newton's method, general theory for one point iteration methods. Aitken extrapolation for linearly convergent sequences, Error tests, Numerical evaluation of multiple roots, roots of polynomials, Mullers method, Non-linear systems of equations, Newton's method for non- linear systems.

Unit II:

Polynomial interpolation theory, Newton's divided differences, finite difference and table oriented interpolation formulas. Forward-differences. Hermite interpolation.

Unit III: The Weierstrass theorem and Taylor's theorem. The minimax approximation problem, the least square approximation problem, orthogonal polynomial, economisation of Taylor series, minimax approximation.

Unit IV:

The trapezoidal rule and Simpson's rule, Newton- Cotes integration formulas.

Text book:

An Introduction to Numerical Analysis by K. E. Atkinson, Johan Wiley and sons, Inc.

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(i) Fluid Dynamics-II

Unit I:

Stress components in a real fluid, relation between Cartesian components of stress translation motion of fluid elements, the rate of strain quadric and principal stresses, some further properties of the rate of the strain quadric, stress analysis in fluid motion, relation between stress and rate of strain, the coefficient of viscosity and laminar flow, the Navier-Stokes equations of motion of a viscous fluid, some solvable problems in viscous flow, diffusion of vorticity, energy dissipation due to viscosity, steady flow past a fixed sphere.

Unit II:

Nature of magneto-hydrodynamics, Maxwell electromagnetic field equations; Motion at rest, Motion in medium , Equation of motion of conducting fluid, Rate of flow of charge, Simplification of electromagnetic field equation. Magnetic Reynold number; Alfven's theorem, The magnetic body force. Ferraro's Law of Isorotation.

Unit III:

Dynamical similarity, Buckingham Theorem. Renold number. Prandtl's boundary layer, Boundary layer equation in two dimensions, Blasius solutions, Boundary layer thickness, Displacement thickness. Karman integral conditions, Separation of boundary layer flow.

Unit IV:

Turbulence: Definition of turbulence and introductory concepts. Equations of motion for turbulent flow. Reynolds Stresses Cylindrical coordinates. Equation for the conservation of a transferable scalar quantity in a turbulent flow. Double correlations between turbulence-velocity components. Change in double velocity correlation with time. Introduction to triple velocity correlations. Features of the double longitudinal and lateral correlations in a homogeneous turbulence. Integral scale of turbulence.

Text Books:

1. Text book of Fluid Dynamics: F. Chorlton; CBS Publishers, Delhi 1985.

2. Fluid Mechanics: Joseph Spurk; Springer.

3. Turbulence by J.O. Hinze, 2nd edition, Mc Graw-Hill, chapter 1 sections 1.1 to 1.7

4. Fluid Mechanics by M.D. Raisinghania, S. Chand and Company, Delhi.

Reference Books:

1. An Introduction to fluid Mechanics: G.K. Batchelor; Foundation Books, New Delhi, 1994.
2. Boundary Layer Theory: H. Schichting; Mc Graw Hill Book Company, New York 1971.

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(ii) Cosmology

Unit I:

Static cosmological models of Einstein and de Sitter and their derivation and its Properties: (i) The geometry of the Universe (ii) Density and pressure (iii) Motion of test particle (iv) Doppler shift (v) comparison with actual universe, Comparison between Einstein and de-Sitter models.

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Unit II:

Cosmological principle, Hubble law, Weyl's postulate, Derivation of Robertson Walker Metric and its properties, Motion of a particle and light rays in FRW model, Red shift, Decelerationparameter and Hubble's constant, Matter Dominated era.

Unit III:

Friedman Model, Fundamental equation of dynamical cosmology, density and pressure of the present universe, Matter dominated era of the universe, critical density, flat, closed and open universe, age of the universe.

Unit IV:

Steady state cosmology, Distance measure in cosmology, Comoving distance, Apparent luminosity and luminosity distance, Angular diameter and Lookback time, Horizons and the Hubble radius; Galaxy count**,** the Particle horizons, the Event Horizon.

Text Books:

1. Relativity, Thermodynamics and Cosmology: Richard C. Tolman, Oxford Press

2. Gravitation and Cosmology : Principles and Applications of the General Theory of Relativity by Steven Weinberg.

References Books:

1. The Classical Theory of Fields, By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press (1978).

2. ecture on General Relativity , Sonu Nilu Publication (2004) by T M Karade, G S Khadekar and Maya S Bendre

3. The Theory of Relativity Moller C, Pub. Oxford University Press (1982).

4. Introduction to theory of relativity, Rosser W.G.V., ELBS (1972).

5. Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press (2003).

6. Relativity: The General Theory, Synge J.L., North Holland Pub. Comp. (1971).

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(iii) Cryptography

Unit I:

Time estimates for doing arithmetic, divisibility and Euclidean algorithm, congruence's, quadratic residues and reciprocity, Fermat's little theorem, applications to factoring, finite fields.

Unit II:

Classical cryptosystems, Public key cryptography, Hash function, Probabilistic encryption, RSA cryptosystem, Pseudo primes, Pollard's P-1 method, The Rho method.

Unit III:

The El Gamal cryptosystem, discrete logarithm, Diffee-Hellman key exchange system, Algorithms for discrete logarithm problem- Shank's algorithm, the Pollard Rhoalgorithm, the Pohlig-Hellman Algorithm, security of ElGamal systems, the ElGamal signature scheme.

Unit IV:

Elliptic curves, Elliptic curve cryptosystems, Elliptic curve primality test, Elliptic curve factorization.

Text books:

1. Neal Koblitz, A Course in Number Theory and Cryptography (second edition), SpringerVerleg.
2. Douglas R. Stinson, Cryptography: Theory and practice (Third Edition), CRC Press.

Scope :

Unit I- From Koblitz's book (Chapter 1 and Chapter 2 excluding Existence and uniqueness of finite fields with prime power number of elements)

Unit II – From Koblitz's book (Chapter 4 –sections 1 and 2, Chapter 5- sections 1 and 2)

Unit III – From Stinson's book (Chapter 6- section 1and 2, Chapter 7- section 3)

Unit IV - From Koblitz's book (Chapter 6)

Reference Books:

1. William Stallings, Cryptography and Network Security, Prentice Hall.

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(iv) Algebraic Topology- II

Unit I:

Simplicial mappings. Chain mappings. Barycentric Subdivision. The Brouwer Degree.
The fundamental theorem of algebra.

Unit II:

No retraction theorem and Brouwer fixed point theorem. Mappings into spheres. Relative homology groups. The exact homology sequence. Homomorphisms of exact sequences.

Unit III:

The excision theorem. The Mayer-Vietoris sequence. Eilenberg-Steenrod axioms for homology theory. Relative homotopy theory. Cohomology groups. Relations between chain and cochain groups.

Unit IV:

Simplicial and chain mappings. The cohomology product. The cap product. Exact sequences in cohomology theory. Relations between homology and cohomology groups.

Text Book:

Topology : J.G. Hocking and G.S. Young : Addison Wesley, 1961

Reference Books :

1. Topology : J.R.Munkres, Prentice Hall, Second Edition, 2000

2. Basic Concepts of Algebraic Topology : Fred H.Croom , Springer Verlag 1978.

M. Sc. Mathematics

Semester-37

Core Elective

Paper – XIV (Code: 4T4)

(v) Operator Theory

Unit I:

Basic concepts about spectrum. Spactral properties of bounded linear operators. Further properties of resolvent and spectrum. Use of complex analysis in spectral theory.

Unit II:

Banach Algebras. Further properties of Banach Algebras. Compact linear operators on normed spaces. Further properties of Compact linear operators. Spectral properties of compact linear operators.

Unit III:

Further spectral properties of Compact linear operators. Operator equations involving compact linear operators. Further theorems of Fredholm type. Fredholm alternative.

Unit IV:

Spectral properties of bounded self adjoint linear operators. Further Spectral properties of bounded self adjoint linear operators. Positive operators. Square roots of a positive operator. Projection operator. Further properties of projections. Spectral family. Statement of spectral representation theorem.

Text Book:

Introductory Functional Analysis with Applications by E. Kreyszig, John Wiley and Sons

Reference Book :

1. Introduction to Functional Analysis by A.E.Taylor and D.C.Lay, John Wiley and Sons

NOTE*: Candidates can choose any one paper from Core elective

M. Sc. Mathematics

Semester-38

PAPER XX : FOUNDATION (For Students other than Mathematics)

Paper – XX (Code: 4T5)

MATHEMATICS-II

Elementary Discrete Mathematics-II

Unit I:

Mathematical Logic: Introduction, Proposition, compound Proposition, Proposition and truth tables, logical equivalence, algebra of Proposition, conditional Proposition, converse, contra positive & inverse, bi conditional statement, negation of compound statements, tautologies & contradictions, normal forms, logic in proof.

Unit II:

Lattice: Lattice as partially ordered sets, their properties, lattices as algebraic system, sub lattices, and some special lattices eg. Complete, complemented and distributive lattices.

Unit III:

Boolean algebra and Logic Circuits: Boolean algebra, basic operations, Boolean functions, De-Morgan's theorem, logic gate, sum of products and product of sum forms, normal form, expression of Boolean function as a canonical form, simplification of Boolean expression by algebraic method, Boolean expression form logic & switching network.

Unit IV:

Graph Theory: Basic terminology, simple graph, multigraph, degree of a vertex, types of a graph, sub graphs of isomorphic graphs, matrix representation of graphs, Euler's theorem on the existence of Eulerian path & circuits, directed graph, weighted graphs, strong connectivity, chromatic number.

Text Book:

Discrete Mathematical structures with applications to computer science by J.P.

Tremblay and R. Manohar, McGraw-Hill book company,1997.

M. Sc. Mathematics

Semester-IV

CORE SUBJECT CENTRIC (Only Students of Mathematics)

Paper – XX (Code: 4T5)

Operations Research–II

Unit I:

Integer Programming: Gomory's cutting plane algorithm (All integer and mixed integer algorithms), Branch and Bound method.

Unit II:

Revised simplex method (with and without artificial variables). Post Optimality Analysis: changes in (i) objective function, (ii) requirement vector, (iii) coefficient matrix; Addition and deletion of variables, Addition of constraints.

Unit III:

Bounded variable technique for L.P.P. Unconstrained optimization, Constrained optimization with equality constraints- Lagrange's multiplier method, Interpretation of Lagrange multiplier.

Unit IV:

Queueing Theory: Basic features of queueing systems, operating characteristics of a queueing system, arrival and departure (birth & death) distributions, inter-arrival and service times distributions, transient, steady state conditions in queueing process. Poisson queueing models- M/M/1, M/M/C for finite and infinite queue length.

Text book:

Operations Research: Kanti Swarup P.K. Gupta and Man Mohan: Sultan Chand and Sons New Delhi.

Recommended Books:

1. H. A. Taha, Operations Research – An Introduction, Prentice-Hall, 1997.

2. J. K. Sharma, Operations Research: Theory and Applications, Macmillan, 1997

3. S. D. Sharma, H. Sharma, Operations Research: Theory, Methods and Applications, Kedar Nath Ram Nath, 1972

4. S. S. Rao, Optimization-Theory and Applications, Wiley Eastern Ltd., 1977.

5. F. S. Hillier, G. J. Lieberman, Introduction to Operations Research, McGraw-Hill, 2001

6. M. S. Bazaraa, H. D. Sherali, C. M. Shetty, Nonlinear Programming-Theory and Algorithms, Wiley-Interscience, 2006

7. A. K. Bhunia and L. Sahoo, Advanced Operations Research, Asian Books Private Limited, New Delhi, 2011.

8. M. Aokie, Introduction to Optimization Techniques: Fundamentals and Applications of Nonlinear Programming, The Macmillan Company, 1971.

SYLLABUS for M. Sc. CHEMISTRY
Choice Based Credit System (Semester Pattern)
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Effective from 2018-2019

Candidates opting for this course are advised to go through the direction relating to the course "DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE, SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM) AND DEGREE OF MASTER OF SCIENCE AND TECHNOLOGY (APPLIED GEOLOGY). SEMESTER PATTERN, (CHOICE BASED CREDIT SYSTEM) (FACULTY OF SCIENCE & TECHNOLOGY)" which is available on R. T. M. Nagpur University website.

The direction will provide details on admission criteria, rules for ATKT, scheme of examination, absorption scheme for CBS students into CBCS pattern, elective papers, foundation course papers, subject centric papers, coding pattern, pattern of question papers, practicals, distribution of marks, seminars, project work, internal assessment, calculation of SGPA and CGPA, etc.

Scheme of teaching and examination under semester pattern Choice Based Credit System **(**CBCS**)** for M.Sc. Program in Chemistry

M. Sc. Chemistry Semester I												
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme						
		Th	Pract	Total		Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
							External Marks	Internal Ass		Th	Pract
(1T1**)**	Paper 1: Inorganic Chemistry	4	-	4	4	3	80	20	100	40	
(1T2**)**	Paper 2: Organic Chemistry	4	-	4	4	3	80	20	100	40	
(1T3**)**	Paper 3: Physical Chemistry	4	-	4	4	3	80	20	100	40	
(1T4**)**	Paper 4: Analytical Chemistry	4	-	4	4	3	80	20	100	40	
Pract. **(**1P1**)**	Practical 1: Inorganic Chemistry	-	8	8	4	3-8*	100**	-	100		40
Pract. **(**1P3**)**	Practical 2: Physical Chemistry	-	8	8	4	3-8*	100**	-	100		40
Seminar 1 **(**1S1**)**	Seminar 1	2	-	2	1			25	25	10	
	TOTAL	18	16	34	25		520	105	625	170	80

M. Sc. Chemistry Semester II												
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme						
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks		
		Th	Pract	Total			External Marks	Internal Ass		Th	Pract	
(2T1)	Paper 5: Inorganic Chemistry	4	-	4	4	3	80	20	100	40		
(2T2)	Paper 6: Organic Chemistry	4	-	4	4	3	80	20	100	40		
(2T3)	Paper 7: Physical Chemistry	4	-	4	4	3	80	20	100	40		
(2T4)	Paper 8: Analytical Chemistry	4	-	4	4	3	80	20	100	40		
Pract. (2P2)	Practical 3: Organic Chemistry	-	8	8	4	3-8*	100**	-	100		40	
Pract. (2P4)	Practical 4: Analytical Chemistry	-	8	8	4	3-8*	100**	-	100		40	
Seminar 2 (2S1)	Seminar 2	2	-	2	1			25	25	10		
	TOTAL	18	16	34	25		520	105	625	170	80	

M. Sc. Chemistry Semester III												
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme						
		Th	Pract	Total		Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
(3T1)	Paper 9: Special – I (Inorganic/ Organic / Physical / Analytical) Chemistry	4	-	4	4	3	80	20	100	40		
(3T2)	Paper 10: Special – II (Inorganic/ Organic / Physical / Analytical) Chemistry	4	-	4	4	3	80	20	100	40		
Elective 1 (3T3)	Paper 11: A) NuclearChemistry I (3T3A) ORB) Environmental Chemistry I (3T3B) ORC) Polymer Chemistry I(3T3C) ORD) Medicinal Chemisrty I(3T3D)	4	-	4	4	3	80	20	100	40		
Foundation Course 1 / Core Subject Centric 1 (3T4)	Paper 12: Applied AnalyticalChemistry-I / Spectroscopy I	4	-	4	4	3	80	20	100	40		
Pract. Core 9 & 10 (3P1)	Practical 5: Special (Inorganic/ Organic / Physical / Analytical) Chemistry	-	8	8	4	3-8*	100**	-	100		40	
Pract. Core Elective 1 (3P3)	Practical 6: A) Nuclear Chemistry I ORB) Environmental Chemistry I ORC) Polymer Chemistry I ORD) Medicinal Chemisrty I	-	8	8	4	3-8*	100**	-	100		40	
Seminar 3 (3S1)	Seminar 3	2	-	2	1			25	25	10		
	TOTAL	18	16	34	25		520	105	625	170	80	

M. Sc. Chemistry Semester IV				
Code	Theory / Practical	Teaching scheme	Credits	Examination Scheme

		(Hours / Week)									
		Th	Pract	Total		Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
							External Marks	Internal Ass		Th	Pract
(4T1)	Paper 13: Special – I (Inorganic/ Organic / Physical / Analytical) Chemistry	4	-	4	4	3	80	20	100	40	
(4T2)	Paper 14: Special – II (Inorganic/ Organic / Physical / Analytical) Chemistry	4	-	4	4	3	80	20	100	40	
Elective 2 (4T3)	Paper 15: A) Nuclear Chemistry II ORB) Environmental Chemistry II ORC) Polymer Chemistry II ORD) Medicinal Chemisrty II	4	-	4	4	3	80	20	100	40	
Foundation Course 2 / Subject Centric 2 (4T4)	Paper 16: Applied Analytical Chemistry II / Spectroscopy II	4	-	4	4	3	80	20	100	40	
Pract. (4P1)	Practical 7: Special (Inorganic/ Organic / Physical / Analytical) Chemistry	-	8	8	4	3-8*	100**	-	100		40
Project (4PROJ1)	Project	-	8	8	4	3-8*	100**	-	100		40
Seminar 4 (4S1)	Seminar 4	2	-	2	1			25	25	10	
	TOTAL	18	16	34	25		520	105	625	170	80

NOTE Sem III & IV:

Foundation Course: Candidate can opt for any one foundation course paper in the semester III and IV. However, Student shall opt for this paper from any other subject other than his / her main subject for postgraduation. If the candidate decides to opt for foundation course papers then he/she shall not be eligible to opt for Core (Subject Centric) papers in their respective subjects.

Core (Subject Centric): Candidate can opt for this paper as shown in the semester III and IV in their main subject of postgraduation only. If the candidate decides to opt for Core (Subject Centric) papers in their main subject of

postgraduation then he**/**she shall not be eligible to opt for foundation course papers neither in their own subject nor in any other subject**).**

- General Scheme for Distribution of Marks in Practical Examination in Chemistry
  Time:8-9h (One day Examination) Marks:100

Exercise-1	- 30 Marks	- Evaluated jointly by Internal and External Examiner
Exercise-2	- 30 Marks	- Evaluated jointly by Internal and External Examiner
Record	-20 Marks	- Evaluated by Internal
Viva-Voce	-20 Marks	- Evaluated by External
Total	**-** 100 Marks	

- General Scheme for Distribution of Marks in Project Examination in Chemisrty
  The project work will carry total 100 marks and will be evaluated by both external and internal examiners in the respective Department / Center/ Affiliated College.
  The examiners will evaluate the experimental project work taking into account the coverage of subject matter, presentation, references etc.

For written Project work	- 40 Marks	-	Evaluated jointly by External and Internal
For Presentation	- 20 Marks	-	Evaluated jointly by External and Internal
ForViva-Voce	- 20 Marks	-	Evaluated by External Examiner
Internal Assessment	- 20 Marks	-	Evaluated by Internal Examiner
Total	**-** 100 Marks		

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SYLLABUS for M. Sc. CHEMISTRY
Choice Based Credit System (Semester Pattern)
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Effective from 2015-2016

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Semester I
Paper – I (Code: 1T1)
Inorganic Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I 5h

A) Stereochemistry and Bonding in Main Group Compound:VSEPER-Shape of simple inorganic molecules and ions containing lone pairs, various stereo chemical rules and resultant geometry of the compounds of non-transitional elements, short coming of VSEPR model. Bent's rule and energetics of hybridization.

B) Metal – Ligand Bonding: 10h

Crystal Field Theory: Splitting of d-orbital in tetragonal, square planar and trigonal bipyramidcomplexes. John teller effect, spectrochemical series, nephelauxetic effect. Limitaion of crystal field theory. M.O.Theory for octahedral, tetrahedral & square planar complexes with and without π-bonding.

Unit-II

A) Metal – Ligand Equilibria in Solution: 5h

Stepwise and overall formation constants; trends in stepwise formation constants; factors affecting stability of metal complexes with reference to nature of metal ion, ligand, chelate effect and thermodyanamic origin. Determination of formation constant by :

(1) spectrophotometric method (Job's and Mole ratio method)

(2) Potentiometric method (Irving-Rossotti Method)

B) Reaction Mechanism of Transition metal complexes: 10h

Energy Profile of a reaction, reactivity of metal complexes, Inert and Labile complexes, Kinetics of Octahedral substitution: Acid hydrolysis, factors affecting acid hydrolysis, Stereochmistry of intermidiates in SN^1& SN^2 , Base hydrolysis, Conjugate base mechanism, Direct and indirect evidences in favour of conjugate mechanism, Annation reaction, reaction without metal-ligand bond breaking.

Unit-III: Cluster- I 15h

Boron hydrides: Classification, nomenclature, structure, bonding and topology of boranes, 4-digit coding (s, t, y, x) numbers for higher boranes and their utilities. Chemistry of diboranes: Study of Metalloboranes, Carboranes and Metallocarboranes with reference to preparations and structures.

Unit – IV: Cluster-2

A) Metal-Metal bonds: 10h

Occurrence of metal-metal bond, Classification of metal clusters, Binuclear, trinuclear, tetranuclear, pentanuclear and hexanuclear with reference to halide, oxide, alkoxide and acetate clusters.

B) Isopoly, Heteropoly acids and their anions. 5h

List of Books

1) S. F. A. Kettle, J. N. Murral and S. T. Teddler: Valency Theory
2) C. A. Coulson: Valency

3) J. E. Huheey :Inorganic Chemistry
4) F .A. Cottonand G. Wilkinson: Advanced Inorganic Chemistry 3rd, 5thand 6th Editions.
5) A. F. Willims: Theoretical Approach in inorganic chemistry.
6) A. Mannas Chanda: Atomic Structure and chemical Bonding
7) L. E. Orgel: An Introduction To transition metal chemistry, Ligand field theory, 2nd Edition.
8) J. J. Logowski: Modern Inorganic Chemistry
9) B.Durrant and P.J.Durrant: Advanced Inorganic Chemistry
10) J. C. Bailar: Chemistry of coordination compounds.
11) W. L. Jolly: Modern Inorganic Chemistry
12) R. S. Drago: Physical methods in inorganic chemistry.
13) Waddington: Nonaqueous solvents.
14) Sisler: Chemistry of nonaqueous solvents.
15) A. K. Barnard: Therotical Inorganic Chemistry
16) Emeleus and Sharpe: Modern Aspect of Inorganic Chemistry.
17) F. A. Cotton: Chemical Applications of Group theory.
18) Jones: Elementary Coordination chemistry.
19) B. N. Figgis: Introduction to Ligand field.
20) S. F. A. Kettle: Coordination chemistry.
21) M.C.Day and J.Selbin: Theoretical Inorganic Chemistry.
22) J. Lewin and Wilkins: Modern Coordination Chemistry.
23) Gowarikar, Vishwanathan and Sheedar: Polymer science.
24) H. H. Jattey and M. Orchin: Symmetry in chemistry.
25) D. Schonaland: Molecular Symmetry in chemistry.
26) L. H. Hall: Group theory and Symmetry in chemistry
27) H. H. Jattey and M. Orchin: Symmetry in chemistry
28) R.L.Dutta and A.Symal: Elements of magneto chemistry
29) Inorganic Chemistry 4th Edition, P.Atkins, Oxford University Press.
30) Essential Trends in Inorganic Chemistry, D.M.P.Mingos, Oxford University Press.

Semester I

Paper II (Code: 1T2)

Organic Chemistry

60 h (4 h per week): 15 h per unit — 80 Marks

Unit-I: 15 h

A] Nature and Bonding in Organic Molecule**:**Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyper-conjugation, bonding in fullerenes. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons Huckel's rule, energy level of π-molecules orbitals, annulenes, antiaromaticity, homo-aromoaticity. Aromatic character and chemistry of cyclopentadienyl anion, tropylium cation, tropone and tropolone. Bonds weaker than covalent-addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes

B] Reactive Intermediates**:** Generation, structure, stability and chemical reactions involving carbocations, carbanions, free radical, carbenes, and nitrenes

Unit-II: 15 h

Streochemistry**:** Conformational analysis of cycloalkanes **(**5**-**8 membered rings**)**, substituted cyclohexanes, mono substituted, disubstituted and trisubstituted cyclohexanes, decalines, effect of conformation on reactivity, Cahn**-**Ingold**-**Prelog System to describe configuration at chiral centers**.** Elements of symmetry, chirality, molecules with more than one chiral center, meso compounds, threo and erythro isomers, method of resolution, optical purity, enantiotopic and distereotopic atoms, groups and faces, prochirality, addition**-**elimination reactions, stereospecific and

steroselective synthesis**.** Asymmetrical synthesis, optical activity in absence of chiral carbon **(**biphenyl and allenes**)**

Unit**-**III**:** 15 h

A**]** Reaction mechanism**:** Structure and Reactivity**:** Types of mechanism, Types of reaction, thermodynamics and kinetics requirements, kinetic and thermodynamic control, Hammond**'**s postulate, Curtin**-**Hammett principle, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects, Hard and soft acids and bases**.**

B**]** Aliphatic nucleophilic substitution**:** The SN^1, SN^2, mixed SN^1, SN^2 and SET and SN_i mechanisms**.** Nucleophilicty, effect of leaving group, ambient nucleophiles and ambient substrates regiospecificity, substitution at allylic and vinylic carbon atoms, phase transfer catalysis

C**]** Concept of neighboring group participation Anchimeric assistance with mechanism, neighboring group participation by π and σ bonds, classical and non classical carbocations, Intramolecular displacement by hydrogen, oxygen, nitrogen, sulphur and halogen**.** Alkyl, cycloalkyl, aryl participation, participation in bicyclic system, migartory aptitude, carbocation rearrangements and related rearrangements in neighboring group participation**.**

Unit IV**:** 15h

A**]** Aromatic Nucleophilic Substitution

A general introduction to different mechanisms of aromatic nucleophilic substitution S_NAr, SN^1, benzyne and $S_{RN}1$ mechanisms, arynes as reaction intermediate, Reactivity - effect of substrate structure leaving group and attacking nucleophile. The Von Richter, Sommlet-Hauser and Smiles rearrangements.

B**]** Aromatic electrophilic substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The o/p ratio, ipso attack, orientation in benzene ring with more than one substituents, orientation in other ring system. Friedel-Crafts reaction, Vilsmeir-Hack reaction, Gatterman-Koch reaction, Pechman reaction, Reimer-Tieman reaction, Diazonium coupling.

C**]** Effect of Structure on reactivity**:** Resonance and field effects, Steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft Equation.

List of books

1] Advanced Organic Chemistry –Reaction mechanism and structure. Jerry March, John Wiley
2] Advanced Organic Chemistry- F.A. Carey and R. J. Sunberg, Plenum
3] A Guidebook to Mechanism in Organic Chemistry-Peter Skyes, Longman
4] Structure and Mechanism in Organic Chemistry-C.K. Gold, Cornell University Press
5] Organic Chemistry, R.T. Morrison Boyd. Prentice Hall
6] Modern Organic Chemistry-H.O. House, Benjamin
7] Principal of Organic Chemistry-R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional
8] Reaction Mechanism in Organic Chemistry-S.M. Mukharji and S.P. Singh, Macmilan
9] Stereochemistry of Organic Compounds- D. Nasipuri, New Age International
10] Stereochemistry of Organic Compounds- P. S. Kalsi, New Age International
11] Frontier Orbitals and Organic Chemical Reactions-I. Fleming
12] Orbital Symmetry – R. E. Lehr and A. P. Marchand
13] Reactive Intermediate in Organic Chemistry-N. S. Isaacs
14] Stereochemistry of Carbon Compounds- E. L. Eliel
15] Physical Organic Chemistry-J. Hine
16] Name Reaction in Organic chemistry –Surrey
17] Advanced Organic Chemistry – L. F. Fieser and M. Fieser.
18] Organic Chemistry Vol. I and II - I. L. Finar
19] Modern Organic Chemistry- J.D. Roberts and M. C. Caserio
20] The Search for Organic Reaction Pathways (Longmann), Peter Skyes

21] Organic Chemistry 5th Edition (McGraw Hill), S. H. Pine
22] Organic Chemistry (Willard Grant Press Botcon), John Mcmurry
23] A Textbook of Organic Chemistry- R. K. Bansal New Age International
24] New Trends in Green Chemistry –V. K. Ahluwalia and M. Kidwai, Anamaya publishers New Delhi
25] Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press
26] Organic Chemistry, 4th Edition, G Marc Loudon, Oxford University Press

Semester I
Paper III (Code: 1T3)
Physical Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

UNIT I: CLASSICAL THEMODYNAMICS 15h

A] Recapitulation of Laws of thermodynamics, Exact and inexact differentials, condition of exactness, Ptaff differential expression and equations, Applications of Ptaff differential equations to first and second law of thermodynamics, Carathéodory's principle and its equivalence to the Kelvin Plank and Clausius statement of the Second law of Thermodynamics, Homogeneous functions of degree 0 and 1, extensive and intensive properties, derivation of thermodynamic equations of state, Maxwell's relations.

B] Third law of thermodynamics, Nernst Heat Theorem, unattainability of absolute zero, calculation of entropy based on third law of thermodynamics, residual entropy and its application. Virial equation of state.

UNIT II: GIBBS FUNCTION AND PHASE EQUILIBRIA 15h

A] Partial molar quantities: Determination of partial molar quantities, chemical potential, partial molar volume, Gibbs Duhem equation, Gibbs Duhem Mergules equation, Extent of advancement of reaction (ξ), thermodynamic criteria of chemical equilibrium.

B] Gibbs Phase rule and its derivation, calculation of degrees of freedom, reduced phase rule, construction of phase diagram, one component systems (Helium, carbon), 1st and 2nd order phase transition, lambda line, two component systems forming solid solutions having congruent and incongruent melting point, partially miscible solid phase, three component systems, graphical presentation, influence of temperature, systems with 1, 2, 3 pairs of partially miscible liquids, transition points.

UNIT III: SURFACE PHENOMENA AND MACROMOLECULES 15h

A] Recapitulation of Surface tension, Adsorption: Freundlich adsorption isotherm, Langmuir theory, Gibbs adsorption isotherm, BET theory and estimation of surface area, enthalpy and entropy of adsorption. Surface film on liquids and catalytic activity, Electro-kinetic phenomena, Surface active agents, hydrophobic interactions, micellization, Critical Micelle Concentration (CMC), mass action model and phase separation model of micelle formation, shape and structure of micelles, factors affecting CMC, micro-emulsion and reverse micelles.

B] Macromolecules: Definitions, Number and mass average molecular weights, molecular mass determination by Osmometry, Viscometry, Sedimentation, Diffusion, light scattering method, Numerical.

UNIT IV: CHEMICAL KINETICS 15h

A] Temperature dependence of chemical reaction rates, Arrhenius equation, Energy of activation, pre-exponential factor and its limitations, Collision theory and its limitations, steric factors, Transition State theory of gas and liquid phase bimolecular reactions, comparison of three theories of reaction rates.

B] Bodeinstein steady state approximation and its application in consecutive reactions, Dynamics of unimolecular reactions: Lindeman-Hinshelwood mechanism, RRKM theory, Thermodynamic formulation of transition state theory, Enthalpy, Gibbs free energy and enthalpy of activation.

List of books

1. R. P. Rastogi and R. R. Mishra, An Introduction to Chemical Thermodynamics, Vikas Publication, Gorakhpur, 2010.
2. P. W. Atkins and D. Paula, Physical Chemistry, 8th Edition, Oxford University Press, 2010.
3. E. N. Yenemin, Fundamentals of Chemical Thermodynamics, MIR, Publications.
4. G. K. Vemulapalli, Physical Chemistry, Prentice – Hall of India, 1997.
5. S. Glasstone andDe Van No Strand, Thermodynamics for Chemists, 1965.
6. S. M. Blinder, Advanced Physical Chemistry,
7. D. Mcquarie and J. Simon, Physical Chemistry – A Molecular Approach, University Press, 2000
8. G. M. Barrow, Physical Chemistry, Tata Mc-Graw Hill, V edition 2003.
9. H. K. Moudgil, Text Book of Physical Chemistry, Pretice Hall of India, New Delhi, 2010.
10. G.M.Panchenkov and V.P.Labadev, " Chemical Kinetics and catalysis", MIR Publishing
11. E.A. Moelwyn- Hughes, " Chemical Kinetics and Kinetics of Solutions", Academic
12. K.J.Laidler, Chemical Kinetics, Third Edition (1987), Harper and Row, New York.
13. J.Raja Ram and J.C.Kuriacose, Kinetics and Mechanism of Chemical Transformations MacMilllan IndianLtd., New Delhi (1993)
14. C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, Vol 1., Elsevier Publications, New York, 1969.
15. C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, Vol 2., Elsevier Publications, New York, 1969.
16. S. Glasstone, K. J. Laidler and H. Eyring, The Theory of Rate Processes, Mc-Graw Hill, New York, 1941.
17. A. Findley, The Phase Rule and its Applications, Longmans Green and Co., Mumbai.
18. K. S. Birdi, Surface Chemistry Essentials, CRC Press, New York, 2014.
19. Eric Keightley Rideal, An Introduction to Surface Chemistry, Cambridge University Press, 1926.
20. D. M. Ruthven, Principles of Adsorption and Adsorption Processes, John Wiley & Sons, NewYork, 1984.
21. A. W. Adamson, A. P. Gasi, Physical Chemistry of Surfaces, Wiley, 2007.
22. P. C. Hiemenz and R. Rajagopalan, Principles of Colloid and Surface Chemistry, CRC Taylor and Fransis, 2007.
23. P. D. Hede and S. P. Beier, Inorganic and Applied Chemistry, e-Book, 2007.
24. Santosh Kumar Upadhyay, Chemical Kinetics and Reaction Dynamics, Springer 2006.
25. E.M. Mc Cash, *Surface Chemistry*, Oxford University Press, Oxford (2001).
26. G. K. Agrawal, Basic Chemical Kinetics, Tata-Mc-Graw Hill, 1990.
27. N. B. Singh, N. S. Gajbhiye, S. S. Das, Comprehensive Physical Chemistry, New Age International, 2014.
28. K. L. Kapoor, Text Book of Physical Chemistry, Vol – I to Vol-VI, 2011.

Semester I

Paper IV (Code: 1T4)

Analytical Chemistry

60 h (4 h per week): 15 h per unit — 80 Marks

Unit I: Introduction and statistical analysis — 15h

Introduction to analytical chemistry: Types of analysis-qualitative and quantitative. Classification of analytical methods- classical and instrumental, basis of their classification with examples.

Statistical analysis and validation: Errors in chemical analysis. Classification of errors-systematic and random, additive and proportional, absolute and relative. Accuracy and precision. Mean, median, average deviation and standard deviation. Significant figures and rules to determine significant figures. Calculations involving significant figures. Confidence limit, correlation coefficient and regression analysis. Comparison of methods: F-test and T-test. Rejection of data based on Q-test. Least squares method for deriving calibration graph. Application of Microsoft

Excel in statistical analysis (statistical functions and spreadsheets in MS-Excel). Validation of newly developed analytical method. Certified reference materials (CRMs). Numerical problems.

Unit II: Separation techniques 15h

*Chromatography:*Definition and Classification. Techniques used in Paper, Thin Layer and Column chromatography. Applications in qualitative and quantitative analysis.

*Ion exchange:*Principle and technique. Types of ion exchangers. Ion exchange equilibria. Ion exchange capacity. Effect of complexing ions. Zeolites as ion-exchangers. Applications.

*Solvent extraction:*Principle and techniques. Distribution ratio and distribution coefficient. Factors affecting extraction efficiency: Ion association complexes, chelation, synergistic extraction, pH. Numericals based on multiple extractions. Role of chelating ligands, crown ethers, calixarenes and cryptands in solvent extraction. Introduction to Solid phase extraction (SPE) and Microwave assisted extraction (MAE), Applications.

Unit III: Classical methods of analysis 15h

Volumetric analysis: General principle. Criteria for reactions used in titrations. Primary standards and secondary standards. Theory of indicators. Types of titrations with examples- Acid-base, precipitation, redox and complexometric. Titration curves for monoprotic and polyprotic acids and bases. Indicators used in various types of titrations. Masking and demasking agents.

Gravimetric analysis: General principles and conditions of precipitation. Concepts of solubility, solubility product and precipitation equilibria. Steps involved in gravimetric analysis. Purity of precipitate: Co-precipitation and post-precipitation. Fractional precipitation. Precipitation from homogeneous solution. Particle size, crystal growth, colloidal state, aging and peptization phenomena. Ignition of precipitates.

Unit IV: Electrochemical methods of analysis-I 15h

Conductometry: Concepts of electrical resistance, conductance, resistivity and conductivity. Specific, molar and equivalent conductance and effect of dilution on them. Measurement of conductance. Kohlrausch's law, Applications of conductometry in determination of dissociation constant, solubility product. Conductometric titrations. High frequency titrations. Numerical problems.

Potentiometry: Circuit diagram of simple potentiometer. Indicator electrodes: hydrogen electrode, quinhydrone electrode, antimony electrode and glass electrode. Reference electrodes: Calomel electrode and Ag/AgCl electrode. Theory of potentiometric titrations. Acid-base, redox, precipitation and complexometric titrations. Nernst equation, standard electrode potential, Determination of cell potential, n, K_f and K_{sp}. pH titrations. Buffers and buffer capacity. pH of buffer mixtures based on Henderson-Hasselbalch equation.

List of books:

1. Quantitative analysis: Day and Underwood (Prentice-Hall of India)
2. Vogel's Text Book of Quantitative Inorganic Analysis-Bassett, Denney, Jeffery and Mendham (ELBS)
3. Analytical Chemistry: Gary D. Christian (Wiley, India).
4. Instrumental Methods of Analysis: Willard, Merrit, Dean, Settle (CBS Publishers, Delhi, 1986)
5. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
6. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
7. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
8. Analytical Chemistry: Problems and Solution- S. M. Khopkar (New Age International Publication)
9. Basic Concepts in Analytical Chemistry: S. M. Khopkar (New Age International Publication)
10. Advance Analytical Chemistry: Meites and Thomas: (Mc Graw Hill)
11. An Introduction to Separation Science: L. R. Shyder and C. H. Harvath (Wiley Interscience)
12. Fundamentals of Analytical Chemistry: S. A. Skoog and D. W. West
13. Instrumental Methods of Chemical Analysis: G. W. Ewing

Semester I
Practical-I (Code: 1P1)

Inorganic Chemistry

12 h /week Marks:100

I. Preparation of Inorganic Complexes and their characterization by:

Elemental analysis and physico-chemical methods (Electronic and IR Spectra, magnetic susceptibility measurements, Thermal analysis and Molar conductance studies).

1. K_3 [Al $(C_2O_4)_3$]$(H_2O)_3$ 2. [VO (acac) $_2$] 3. Na [Cr $(NH_3)_2(SCN)_4$]
4. $K_3[Cr(SCN)_6]$. 5. [Mn (acac) $_3$] 6. K_3 [Fe $(C_2O_4)_3$]
7. Hg [Co (SCN) $_4$] 8. [Co (Py) $_2$ Cl_2] 9. [Cu_2 $(CH_3COO)_4(H_2O)_2$]
10. [Ni (DMG) $_2$] 11.$[Ni(NH_3)_6]Cl_2$ 12. $[Cu(NH_3)_4(H_2O)_2]SO_4$

II. Quantitative Analysis:

Separation and determination of two metal ions from the following alloys involving:
Volumetric, Gravimetric and Spectrophotometric methods

i) Copper (II) and Nickel (II)
ii) Copper (II) and Zinc (II)
iii) Nickel (II)—Zinc (II) and
iv) Copper (II)—Iron (III)

III. Qualitative analysis of radicals:

Semi-micro Analysis of inorganic mixture containing four cations out of which two will be rare metal ions such as W, Mo,Se,Ti,Zr,Ce,Th,V and U.(Spot Test for individual cations should be performed)

Semester I

Practical-II (Code: 1P3)

Physical Chemistry

12 h /week Marks: 100

It is expected to perform minimum 14 experiments in a semester.

1. To study the variation of volume contraction with mole fraction of alcohol in alcohol -water system
2. To determine the activation parameters of viscous flow for a given liquid.
3. To Determine the critical micelle concentration (CMC) of a given surfactant / soap / shampoo by surface tension measurements.
4. Determination of molecular mass of a polymer by viscometry method.
5. To determine integral heat of KNO_3, at two different conc. and calculation of heat of dilution.
6. Effect of 1% NaCl, 1% succinic acid, 0.5% naphthalene on CST in phenol-water systems.
7. Distribution of succinic acid in H_2O- benzene, H_2O-ether and comparison of distribution coefficient.
8. To construct the phase diagrams of two components system (phenol- urea, diphenyl aminebenzophenone; a-naphtyl amine-phenol) forming compounds with congruent melting points.
9. To study the mutual solubility of glycerol-m-toluidine and to determine congruent points.
10. To study kinetics of hydrolysis of an ester by NaOH reaction.
11. To determine equilibrium constant of the equation $KI+I_2=KI_3$ by distribution method.
12. To study the kinetics of the reaction between potassium persulphate and potassium iodide.
13. Determination of order of reaction of oxidation of ethyl alcohol by acid dichromate.
14. To titrate conductometrically monobasic and dibasic acids with NaOH and determine the strength of given acid.
15. To determine equivalent conductance of weak electrolyte at infinite dilution by kaulrausch's method.
16. Determination of heat of reaction, entropy change and equilibrium constant of the reaction between metallic zinc and Cu^{+2} ions in solution.
17. Determination of thermodynamic constants G, H, S for $Zn^{+2}+H_2SO_4 \rightarrow ZnSO_4+ 2H^+$ by emf measurement.

18. Titration of Ferrous Ammonium Sulphate against ceric sulphate and hence the formal redox potential of $Fe^{2+} \rightleftharpoons Fe^{3+}$ and $Ce^{3+} \rightleftharpoons Ce^{4+}$ systems.
19. To determine the pH of a buffer solutions using a quinhydrone electrode
20. Complexometric titrations (EDTA based)

List of Books

1. Vogel A,IIIrd Edition : A Textbook Of Quantitative Inorganic Analysis, Longman
2. J. B. Yadav, Practical Physical Chemistry
3. Das and Behra, Practical Physical Chemistry
4. Carl W. Garland, Joseph W. Nibler and David P. Shoemaker, Experiments in Physical Chemistry, Mc-Graw Hill, 8th Edition, 2009.
5. Farrington Daniels, Joseph Howard Mathews, John Warren Williams, Paul Bender, Robert A. Alberty, Experimental Physical Chemistry, Mc-Graw Hill, Fifth Edition, 1956.
6. John W. Shriver and Michael George, Experimental Physical Chemistry, Lab Manual and Data Analysis, The University of Alabama in Huntsville, Fall 2006
7. Day And Underwood :Quantitative Analysis
8. Merits And Thomas:Advanced Analytical Chemistry
9. Ewing, G. W. : Instrumental Methods Of Chemical Analysis, Mcgraw-Hill
10. Drago, R.S:Physical Methoods In Inorganic Chemistry
11. Christain G.D:Analytical Chemistry
12. Khopkar S.M.:Basic Concept of Analytical Chemistry
13. Koltath And Ligane:Polorography
14. Braun:Instrumental Methods of Chemical Analysis
15. Willard, Merritt And Dean: Instrumental Methods of Chemical Analysis ,Van Nostrand
16. Strouts,Crifi;Llan And Wisin: Analytiacl Chemistry
17. Skoog S.A. And West D. W.:Fundamental Of Analytical Chemistry
18. Dilts R.V.: Analytiacl Chemistry
19. Jahgirdar D.V :Experiments In Chemistry
20. Chondhekar T.K: Systematic Experiments In Physical Chemistry, Rajbog S.W., Aniali Pubn.
21. Wlehov G. J: Standard Methods Of Chemicalanalysis 6th Ed
22. Akjmetov, N :General And Inorganic Chemistry

Semester I

Seminar-I (Code: 1S1)

2 h /week Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 25marks (1credit). Seminar should be delivered by the student under the guidance of concerned teacher on the topic allotted by the teacher. The topic will be related to the syllabus. Marks will be allotted by a group of teachers.

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M.Sc. Chemistry
Semester II
Paper V (Code: 2T1)
Inorganic Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

A) Electronic spectra of Transition Metal complexes 10h

Determining the Energy terms, Spin-orbit (L-S) coupling scheme, Hund's rule, Hole Formulation, Derivation of the term symbol for a d^2 configuration, Electronic spectra of transition metal complexes – Laporte 'orbital' selection rule,spin selection rule. Orgel diagrams for octahedral metal complexes. Charge transfer spectra, Racah parameters, calculations of 10Dq, B, β parameters.Tanabe- Sugano Diagrams of octahedral complexes with d^2& d^8 configuration.

B) Magnetic Properties of Transition Metal complexes 5h

Abnormal magnetic properties, orbital contributions and quenching of orbital angular momentum, spin-orbit coupling. Magnetic moment, electronic spectra and structure of tetrahalocobalt(II) complexes, tetrahedral and octahedral Ni(II) complexes. High spin-low spins crossover.

Unit – II 15h

Reaction mechanism of Transition Metal Complexres-II: Substitution reaction in square planer complexes: the trans effect, cis effect, steric effect, solvent effect, effect of leaving group, effect of charge, effect of nucleophile, effect oftemperature. Trans effect theories, uses of trans-effect, mechanism of substitution reactions in Pt(II) complexes.Electron transfer reactions. Types of electron transferreactions, conditions of electron transfer, and mechanism of one-electron transfer reactions, outer sphere and inner sphere mechanisms, two electron transfer reactions complimentary and non-complimentary reactions. Tunneling effect, cross-reaction, Marcus-Hush theory, bridged activated mechanism.

Unit-III: Metal pi-Complexes - I 15h

Metal carbonyls: Structure and bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, important reaction of metal carbonyls.Metal carbonyl clusters with reference to classification, EAN rule, synthesis and structures.

Unit – IV: Metal pi-Complexes – II 15h

Metal nitrosyls: Nitrosylating agents for synthesis of metal nitrosyls, vibrational spectra and X-ray diffraction studies of transition metal nitrosyls for bonding and structureelucidation, important reactions of transition metal nitrosyls, structure and bonding. Dinitrogen and dioxygen complexes. Wilkinson's catalyst and Vaska's compound.

List of Books

1. J.E.Huheey :Inorganic Chemistry
2. F.A.Cottonand G. Wilkinson: Advanced Inorganic Chemistry 3rd, 5th and 6th Editions.
3. A.F. Willims: Theoretical Approach in inorganic chemistry.
4. Mannas Chanda: Atomic Structure and chemical Bonding
5. L. E. Orgel: An Introduction To transition metal chemistry, Ligand field theory, 2nd Edition.
6. J. J. Logowski: Modern Inorganic Chemistry
7. B.Durrant and P.J.Durrant: Advanced Inorganic Chemistry
8. J C. Bailar: Chemistry of coordination compounds.
9. W. L. Jolly: Modern Inorganic ChemistryJones: Elementry Coordination chemistry.
10. B. N. Figgis: Introduction to Ligand field.
11. M.C.Day and J.Selbin: Therotical Inorganic Chemistry.
12. J. Lewin and Wilkins: Modern Co-ordination chemistry.
13. Purcell and Kotz: Inorganic Chemistry.

14. D. Banerjea: Co-ordination chemistry, Tata Mc. Graw. Pub.
15. A.F. Wells: Structural inorganic chemistry, 5th Edition, Oxford.
16. S. G. Davies: Organotransition metal chemistry applications to organic synthesis.
17. R. C. Mehrotra: Organometallic chemistry Tata McGraw Hill. Pub.
18. G. S. Manku: Thereotical priciples of inorganic chemistry
19. A. B. P. Lever: Inorganic electronic spectroscopy.
20. R.C.Maurya:Synthesis and charecterisation of novel nitrosyls compounds, Pioneer Pub. Jabalpur2000.
21. R.H.Crabtree:The Organometalic chemistry of Transition metals, John Wiley.
22. D.N.Styanaryan:Electronic Absorption Spectroscopy and related techniques, University Press.
23. R. S. Drago: Physical methods in inorganic chemistry
24. F.Basolo andG.Pearson: Inorganic Reaction Mechanism
25. Organometallics II and I complexes with transition metal- carbon bonds: Manfred Bochmann- Oxford Press.
26. Advanced Inorganic Chemistry Vol I and II – Satyaprakash, Tuli, Bassu and Madan- S Chand.
27. M.Tsusui,M.Nlevy,M.Ichikwa and K.Mori:Introduction to metal pi-complexe chemistry,Plenum press,NY
28. A.E.Martel;Coordination Chemistry-VolIandII,VNR.

Semester II

Paper VI (Code: 2T2)

Organic Chemistry

2T2

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I 15 h

A] Addition to carbon-carbon multiple bond: Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, Orientation and stereochemistry, Addition to cyclopropanes, Hydrogenation of double bond and triple bonds. Hydrogenation of aromatic rings, hydroboration, Michael reaction, Robinson annulation

B] Addition to carbon-hetero atom multiple bond: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters, and nitriles, Addition of Grignard reagents, organozinc and organolithium reagents to carbonyls and unsaturated carbonyl compounds, Wittig reaction, Mechanisms of condensation reactions involving enolates- Aldol, Knoevengel, Claisen, Mannich, Benzoin, Perkin, Stobbe reaction, Hydrolysis of esters and amide.

Unit-II 15 h

A] Mechanism of molecular rearrangement: Classification and General mechanistic treatment of electrophilic, nucleophilic and free radical moleculer rearrangement. Mechanism of the following rearrangement –Wagner-Meerwin, Pinacol-Pinacolone, Tiffenev –Demjnov ring expansion, benzil-benzilic acid, Favorski, Wolff, Arndt-Eistert synthesis, Curtius Lossen, Beckman, Hoffman, Schmidt rearrangement.

B] Elimination reactions: The E_1, E_2 and E_1CB mechanisms and orientation of the double bond, Saytzeff and Hoffman's rule, Effect of substrate structure, attacking base, leaving group and medium, Mechanism and orientation in pyrolytic elimination

UNIT-III

Free radical reactions: Generation of free radicals, Type of free radical reactions, free radical substitution mechanism at an aromatic substrate, aliphatic substrate, reactivity at a bridgehead position. Neighbouring group assistance, reactivity for aliphatic and aromatic substrates, reactivity in attacking radicals, effect of solvent on reactivity.Halogenation at an alkyl carbon, allylic carbon (NBS), hydroxylation at an aromatic carbon by means of Fenton's reagent. Auto-oxidation,

chlorosulphonation (Reed Reaction) Coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction, iododecarboxylation, Barton reaction, Hoffmann-Loefler-Freytag reaction

Unit IV: Green chemistry 15 h

Green chemistry: Basic principles of green chemistry, calculation of atom economy of rearrangements, addition, substitution and elimination reaction with suitable examples, Case study of Bhopal gas tragedy and Seveso disaster, Synthesis involving basic principles of green chemistry-paracetamol, Ibuprofen, hydroquinone, adipic acid, ε-caprolactum, styrene, urethanes, Free radical bromination, Multi-component reactions (Biginelli, Ugi and Passerini reaction), Prevention or minimization of hazardous products, choice of solvents. Sonochemistry, microvave induced reactions, polymer supported reagents, reactions in aqueous medium, zeolites and ionic liquid supported reaction, Solvent free reactions, electrochemical reactions, Biocatalysts in Organic synthesis.

List of books

1] Books as Suggested in Semester I for Organic Chemistry
2] A Textbook of organic chemistry- R.K. Bansal
3] New trends in green chemistry –V.K. Ahluwalia and M. Kidwai, Anamaya publishers New Delhi
4] Heterocyclic Chemistry, John Joule, Oxford University Press
5] Books as Suggested in Semester I for Organic Chemistry
6] A Textbook of organic chemistry- R.K. Bansal
7] New trends in green chemistry –V.K. Ahluwalia and M. Kidwai, Anamaya publishers New Delhi
8] Heterocyclic Chemistry, John Joule, Oxford University Press

Semester II

Paper VII (Code: 2T3)

Physical Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

UNIT I: FORMULATION OF QUANTUM MECHANICS

15h

A] Introduction of Quantum Mechanics, Wave Function, Acceptability of Wave Functions, Normalized and Orthogonal Wave Functions, Operators, Operator Algebra, Eigen Functions and Eigen Values of Quantum Mechanical Properties (e.g. Linear, Angular momentum, etc.), Hermitian Operators, Orbital and generalized Angular Momentum, Postulates of Quantum Mechanics, Problems on Operator algebra, Eigen Values and Average Values of quantities.

B] Application of Schrödinger Wave Equation to Simple Systems: Degeneracy in 3-Dimensional Box, Rigid Rotor, Potential Well of Finite Depth (Tunneling Effect), Simple Harmonic Oscillator, The Hydrogen Atom.

UNIT II: THERMODYNAMICS

15h

A] Ideal and Non-ideal Systems: Concept of fugacity, determination of fugacity, excess functions for non ideal solutions, Entropy of mixing, Enthalpy of mixing, Activity and activity coefficients, Concept of ion atmosphere and electrophoretic effect, Debye Hückel theory for activity coefficients of electrolytic solutions, determination of activity and activity coefficients, ionic strength and dependence of activity coefficients on ionic strength, numericals.

B] Nonequilibrium Thermodynamics: Conservation of mass and energy in time dependent closed and open systems, Thermodynamic criteria of irreversibility, rate of entropy production and entropy exchange in irreversible processes. The generation of the concept of Chemical Affinity and the

extent of advancement of chemical reactions, Thermodynamic constraints on the signs of chemical affinity and the velocity of chemical reaction, application to any one coupled reaction.

UNIT III: SOLID STATE CHEMISTRY 15h

A] Introduction to crystals, Unit Cell and lattice parameters, Symmetry elements in crystals, Absence of fivefold axis, Space groups, The Bravais Lattices, Miller Indices, Bragg's Equation, seven crystal system, Packing in crystals, Hexagonal Closest Packing (HCP) Cubic Closest Packing (CCP), Voids, packing fraction, Numericals.

B] Crystal Defects and Non-stiochiometry: Perfect and imperfect crystals, point defects, line and plane defects. Thermodynamics of Schottky and Frenkel defect formation, colour centers, non-stiochiometry and defects.

UNIT IV: STATISTICAL THERMODYNAMICS AND NUCLEAR CHEMISTRY 15h

A] Statistical thermodynamics: Lagrange's Method of Undetermined Multipliers (Conditional Maximization), Stirling Approximation, Concept of Distribution, Thermodynamic Probability and most probable distribution, Maxwell Boltzmann, Bose Einestein, Fermi Dirac statistics, comparison between three statistics.

B] Nuclear Chemistry: Introduction, radioactive decay and equilibrium, thermonuclear reactions, photonuclear reactions, Radiometric titration, isotopic dilution analysis, NAA. Counters: Proportional counter, GM counter, Scintillation counter, Ionization chamber counter.

List of books

1. Ira .N. Levine, Quantum Chemistry, 5th edition(2000), Pearson educ., Inc.New Delhi
2. A.K.Chandra, Introductory Quantum Chemistry, 4th edition (1994), Tata Mcgraw Hill, New Delhi.
3. M.W.Hanna, " Quantum Mechanics in Chemistry", Benjamin
4. L. Pualing and E. B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry, McGraw Hill, New York (1935).
5. R. K. Prasad, Quantum Chemistry, New Age International, Delhi.
6. R. K. Prasad, Quantum Chemistry through problems and solutions, New Age International, New Delhi, 2009.
7. B. C. Reed, Quantum Mechanics, Jones and Bartlett, New Delhi, 2010.
8. R. P. Rastogi and R. R. Mishra, An Introduction to Chemical Thermodynamics, Vikas Publication, Gorakhpur, 2010.
9. P. W. Atkins'and D. Paula, Physical Chemistry, 8th Edition, Oxford University Press, 2010.
10. G. K. Vemulapalli, Physical Chemistry, Prentice – Hall of India, 1997.
11. S. Glasstone, An Introduction to Electrochemistry, East-West Press Pvt. Ltd., New Delhi, 2004.
12. H. K. Moudgil, Text Book of Physical Chemistry, Pretice Hall of India, New Delhi, 2010.
13. S. O. Pillai, Solid State Physics, New Age International, New Delhi, 2102.
14. N. B. Hanny, Treaties in Solid State Chemistry,
15. M. C. Day and J Selbin, Theoretical Inorganic Chemistry, Reinhold Pub. Corp., New York,
16. I Prigogine and R. Defay, Chemical Thermodynamics, Longmans, London, 1954.
17. S. R. DeGroot and P. Mazoor, Non-Equilibrium Thermodynamics, North-Holland Co., Amsterdam, 1969.
18. G. Lebon, D. Jou and Casa Vazquez, Understanding Non-equilibrium Thermodynamics, Springer, 2008.
19. I.Prigoggine, "An Introduction to Thermodynamics of Irreversible Processes," Wiley-Interscience.
20. R. P. Rastogi, Introduction to Non-equilibrium Physical Chemistry, Elsevier, Amsterdam, 2008.
21. G. A. Somorjai, Introduction to Surface Chemistry and Catalysis, Wiley, 2010.
22. M. C. Gupta, Statistical Thermodynamics, New Age International.
23. K. Huang, Statistical Mechanics, Wiley, New Delhi, 2003.
24. Andrew Maczek, *Statistical Thermodynamics,* Oxford University Press Inc., New York (1998).
25. C.N.Rao. Nuclear Chemistry

26. B. G. Harvey, *Introduction to Nuclear Physics and Chemistry,* Prentice Hall, Inc. (1969).
27. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition (1995), Wiely-Eastern Ltd., New Delhi.
28. C.Kittel, " Introduction to solid state Physics",Wiley
29. L.V.Azaroff, " Introduction to solids", McGraw Hill
30. L. E. Smart and E. A. Moore, Solid State Chemistry-An Introduction, CRC Tylor and Fransis, 2005.
31. D. D. Sood, A. V. R. Reddy, Fundamentals of Radiochemistry, Indian Association of Nuclear Chemists and Allied Scientists, 2007.
32. C. N. R. Rao and Gopalakrishnan, "New Directions in Solid State Chemistry " Second Edition, Cambridge University Press.
33. Anthony R. West, "Solid State Chemistry and its Applications" Wiley India Edition.
34. C. Kalidas and M. V. Sangaranarayana, Non-Equilibrium Thermodynamics.
35. D. K. Chakravorty, Solid State, New Age International.

Semester II

Paper VIII (Code: 2T4)

Analytical Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Sampling and quantification 15h

A] *Sampling and sample treatment*: Criteria for representative sample. Techniques of sampling of gases (ambient air and exhaust gases), liquids (water and milk samples), solids (soil and coal samples) and particulates. Hazards in sampling. Safety aspects in handling hazardous chemicals.Sample dissolution methods for elemental analysis: Dry and wet ashing, acid digestion, fusion processes and dissolution of organic samples.

B] *Detection and quantification*: Concepts and difference between sensitivity, limit of detection and limit of quantification, role of noise in determination of detection limit of analytical techniques.Units in chemical analysis and their interconversion.

C] *Stoichiometry:* Stoichiometric and sub-stoichiometric reactions and calculations.

Unit-II: Modern separation techniques 15h

A] *Gas Chromatography*: Principle including concept of theoretical plates and van-Deemter equation. Instrumental set up- carrier gas, sampling system, column and detector. Types of columns, their advantages and limitations. Detectors in GC analysis. Temperature programmed GC. Factors affecting retention, peak resolution and peak broadening.

B] *Liquid chromatography*: Principle, Instrumentation, Advantages and applications of HPLC. Types of columns and detectors. Principle and applications of size exclusion, gel permeation, ion retardation, normal phase and reverse phase chromatography.

C] *Supercritical fluid chromatography*: Introduction and applications.

Unit III: Optical methods of analysis-I 15h

A] Spectrophotometry and Colorimetry: Principle of colorimetry. Beer's law, its verification and deviations. Instrumentation in colorimetry and spectrophotometry (single and double beam). Sensitivity and analytical significance of molar extinction coefficient and λ_{max}. Comparison method, calibration curve method and standard addition method for quantitative estimation. Role of organic ligands in spectrophotometric analysis of metal ions. Ringbom plot and Sandell's sensitivity. Photometric titrations. Determination of pK value of indicator. Simultaneous determination. Composition and stability constant of complex by Job's and mole ratio methods. Derivative spectrophotometry. Numerical problems.

B] Flame photometry: Principle. Instrumentation and types of burners. Factors affecting flame photometric determination. Limitations of flame photometry. Interferences in flame photometry. Applications.

Unit-IV: Electrochemical methods of analysis-II 15h

A] *Polarography*: Principle of DC polarography. Instrumentation in polarography. Advantages and limitations of DME. Types of currents- residual current, migration current, diffusion current, limiting current, adsorption current, kinetic current and catalytic current. Ilkovic equation-diffusion current constant and capillary characteristics. Derivation of equation of polarographic wave and half wave potential. Experimental determination of half wave potential. Reversible, quasi reversible and irreversible electrode reactions. Polarographic maxima and maximum suppressor. Oxygen interference and deaeration. Introduction to pulse, a.c. and oscillographic techniques and their advantages. Applications of polarography in determination of dissolved oxygen, metal ion quantification and speciation, simultaneous determination of metal ions, analysis of organic compounds. Limitations of polarography.

B] Amperometric titrations**:** Principle, types and applications in analytical chemistry.

List of books**:**

1. Quantitative analysis**:** Day and Underwood **(**Prentice**-**Hall of India**)**
2. Vogel's Text Book of Quantitative Inorganic Analysis-Bassett, Denney, Jeffery and Mendham (ELBS)
3. Analytical Chemistry**:** Gary D**.** Christian **(**Wiley India**).**
4. Instrumental Methods of Analysis**:** Willard, Merrit, Dean, Settle (CBS Publishers, Delhi, 1986)
5. Sample Pre-treatment and Separation: R. Anderson (John Wiley and Sons)
6. Stoichiometry: B.I.Bhatt and S.M. Vora, 2nd Edition (Tata Mc-Graw Hill publication)
7. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
8. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
9. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
10. Analytical Chemistry: Problems and Solution- S. M. Khopkar (New Age International Publication)
11. Basic Concepts in Analytical Chemistry: S. M. Khopkar (New Age International Publication)
12. Advance Analytical Chemistry: Meites and Thomas: (Mc Graw Hill)
13. An Introduction to Separation Science: L. R. Shyder and C. H. Harvath (Wiley Interscience)
14. Fundamental of Analytical Chemistry: S. A. Skoog and D. W. West
15. Instrumental Methods of Chemical Analysis: G. W. Ewing
16. Polarography: Koltoff and Ligane
17. Electroanalytical Chemistry: Sane and Joshi (Quest Publications)

Semester II
Practical**-**III **(**Code**:** 2P2**)**
Organic Chemistry

12 h /week Marks: 100

[A**]** Qualitative Analysis**:** Separation, purification and identification of the mixture of two organic compounds (binary mixture with two solid, one solid one liquid and two liquids) using chemical methods or physical techniques.
Minimum 8-10 mixtures to be analyzed.
Purification of the compounds by crystallization, TLC and chromatographic techniques.

[B**]** Organic preparations**:**Student is expected to carry out minimum of 5-6 two stage organic preparation and 5-6 single stage preparation from the following lists.

[1] Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.
[2] Benzophenone → benzhydrol
[3] Aldol condensation: Dibenzal acetone from benzaldehyde.
[4] Sandmeyer reaction: *p*- chlorotoluene from *p*-toluidine
[5] Cannizzaro reaction
[6] Friedel Crafts Reaction: β-Benzoyl propionic acid from succinic anhydride and benzene.
[7] Benzil → 2,4,5-triphenyl imidizole

[8] Sucrose → Oxalic acid
[9] Methyl acetoacetate → 5-methyl-isoxazol-3-ol
[10] Ethyl acetoacetate →4-aryl-6-methyl-3,4-dihydro-2(1*H*)-pyrimidinone ester
[11] Ethyl acetoacetate → Diethyl 1,4-dihydro-2,6-dimethyl-4-phenylpyridine-3,-5dicarboxylate
[12] Dye prepartion : Sulphanilic acid → Methyl orange
[13] Dye prepartion : p-nitroaniline → p-red
[14] Acetanilide →*p*-nitroacetanilide →*p*-nitroaniline
[15] Aniline → 2,4,6-tribromo aniline → 2,4,6-tribromoacetanilide
[16] Nitrobenzene →*m*-dinitrobenzene →*m*-nitroaniline
[17] toluene →p-nitrotoluene →*p*-nitrobenzoic acid
[18] Glycine → Benzoyl glycine → 4-benzilidene-2-phenyl oxazole

Semester II

Practical-IV (Code: 2P4)

Analytical Chemistry

12 h /week Marks: 100

Section (A): Classical methods and separation techniques: Calibration, validation and computers

1. Calibration of pipette and burette.
2. Statistical analysis of data.
3. Use of MS-Excel in statistical analysis of data and curve fitting.

Volumetry

1. Determination of Na_2CO_3 in washing soda.
2. Determination of NaOH and Na_2CO_3 in a mixture.
3. Estimation of nickel in given solution by direct complexometric titration with EDTA using bromopyrogallol red.
4. Estimation of nickel in given solution by complexometric back-titration with EDTA.
5. Estimation of chloride in given solution by Mohr's titration.
6. Estimation of chloride in given solution by Volhard's titration.
7. Determination of volume strength of commercial hydrogen peroxide by redox titration with $KMnO_4$.
8. Estimation of phenol/ aniline by bromination method.
9. Estimation of glucose.
10. Estimation of acetone.
11. Estimation of formaldehyde.
12. Estimation of Mn in the presence of Fe using masking phenomenon (ferromanganese alloy).

Gravimetry

1. Estimation of barium as barium sulphate.
2. Estimation of calcium as calcium oxalate/ calcium carbonate/ calcium oxide.

Separation techniques

1. Qualitative separation of metal ions by paper chromatography for 2/3 components.
2. Determination of ion-exchange capacity of resin.
3. Separation of ions by ion exchange.

Section (B): Instrumental techniques: Electroanalytical techniques

1. Analysis of commercial vinegar by conductometric titration.
2. Estimation of phenol by conductometric titration with NaOH.
3. Determination of strength of HCl and CH_3COOH in a mixture conductometrically.

4. Determination of strength of HCl and oxalic acid in a mixture conductometrically.
5. Determination of strength of oxalic acid and CH_3COOH in a mixture conductometrically.
6. Determination of degree of dissociation and dissociation constant of acetic acid conductometrically.
7. Estimation of phenol in dilute solution by conductometric titration with NaOH.
8. Determination of strength of HCl and CH_3COOH individually and in a mixture potentiometrically.
9. Determination of Fe(II) by potentiometric titration with $K_2Cr_2O_7$.
10. Determination of three dissociation constants of H_3PO_4 by pH-metric/ potentiometric titration.

Optical methods

1. Determination of pK of indicator by colorimetry.
2. To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent.
3. To study the complex formation between Fe(III) and salicylic acid and find the formula and stability constant of the complex colorimetrically (Job's method).
4. To determine the dissociation constant of phenolphthalein colorimetrically.
5. Estimation of iron in wastewater sample using 1,10-phenanthroline.

Note: One experiment from each section should be performed in the examination.

Semester II

Seminar-II (Code: 2S1)

2 h /week Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 25 marks (1 Credit). Seminar should be delivered by the student under the guidance of concerned teacher on the topic allotted by the teacher. The topic will be related to the syllabus. Marks will be allotted by a group of teachers.

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M.Sc. Chemistry
Semester III
INORGANIC CHEMISTRY SPECILIZATION
Paper IX (Code: 3T1)
Special I-Inorganic Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit -I 15h

A) Essential and trace metals in biological systems: Biological functions of inorganic elements, biological ligands for metal ions. Coordination by proteins, Tetrapyrrole ligands and other macrocycle. Influence of excess and difficiency of V, Cr, Mn, Fe, Co, Cu,& Zn. Genetic defects in the absorption of trace elements. Regulation and storage of trace elements. Role of minerals. Toxic effects of metals.

B) Metal storage, transport and biomineralization with respect to Ferritin, Transferrin and Siderophores, Na^+ /K^+ pump. Role of Ca in transport and regulation in living cells.

C) Medicinal use of metal complexes as antibacterial, anticancer, use of cis-platin as antitumor drug, antibiotics & related compounds. Metal used for dignosis and chemotherapy with particular reference to anti cancer drugs.

Unit-II 15h

A) Bio-energetics and ATP cycle: DNA polymerization, metal complexes in transmission of energy, chlorophylls, photosystem I and photosystem II in cleavage of water, Model systems.

B) Electron transfer in Biology: Structure and functions of metalloproteins in electron transfer proteins, cytochromes & Fe-S proteins, Non-heme iron proteins; Rubredoxins, Synthetic models. Biological Nitrogen fixation (in vitro and in vivo)

Unit-III

15h

Transport & Storage of Dioxygen: Heme proteins & oxygen uptake, structure and functions of haemoglobin, myoglobin, hemocyanins & hemerythrin. Perutz mechanism showing structural changes in porphyrin ring system. Oxygenation and deoxygenation. Model compounds. Cyanide poisoningand treatment. Vanadium storage and transport.

Unit-IV 15h

Metallo enzymes: Apoenzymes, Haloenzyme & Coenzyme. The principle involved and role of various metals ini) Zn-enzyme:- Carboxyl peptidase & Carbonic anhydrase. ii) Fe-enzyme:-Catalase Peroxidase & Cytochrome P-450 iii) Cu-enzyme:-Super Oxide dismutase iv) Molybdenum:- Oxatransferase enzymes, Xanthine oxidase,Co-enzyme Vit.B12, Structure of vitamin B12 Co-C bond cleavage, Mutaseactivity of co- Enzyme B-12, Alkylation reactions of Methyl Cobalamin. Synthetc model of enzyme action, stability and ageing of enzyme.

List of Books:

1. Akhmetov, N.: General and Inorganic Chemistry.
2. Aylett, B. and Smith, B.: Problems in Inorganic Chemistry, (English University Press)
3. Bertini, et al: Bioinorganic Chemistry (Viva)
4. Charlot, G and Bezier, D.: Quantitative Inorganic Analysis (johnWiley).
5. Douglas, B. E. McDanirl, D. H. et al: Concept and Models of Inorganic Chemistry (4th edt.) J. Wiley
6. Dutt P. K.: General and Inorganic Chemistry.(Sarat Books House)
7. Fenton, David E.: Biocoordination chemistry, Oxford

8. Jolly, W. L. : Inorganic Chemistry (4th edn.) Addison-Wesley.
9. Katakis, D. and Gordon, G.: Mechanism of Inorganic Reactions.(J.Wiley).

Semester III

Paper X (Code: 3T2)

Special II-Inorganic Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I 15 h

Crystal Structure of Some Simple Compounds:

i) Ionic Crystals &Their structures, radius ratio rule, effect of polarization on crystals.
ii) Covalent structure type- Sphalerite & Wurtzite.
iii) Geometry of simple crystal AB type: NaCl, CsCl & NiAs, reasons for preference for a particular structure in above AB type of compounds.
iv) AB_2 type: Fluorite, antifluorites, Rutile structures. Li_2O, Na_2O,,$CdCl_2$, CdI_2 structures.
v) Ternary Compounds ABO_3 type: Perovskite, Barium titanate, lead titanate, $CaTiO_3$, Tolerance factor, charge neutrality & deviation structures. $FeTiO_3$.

Unit-II 15h

A) AB_2O_4 type- compounds: Normal & inverse,2-3 and 4-2 spinel,packing of oxygen in tetrahedral & octahedral sites, sites occupancy number of site surrounding each oxygen,application of charge neutrality principles, site preferences in spinel, distorted spinel.Hausmannite(Jahn-Teller distortions),Factors causing distortion in spinel.

B) Lattice Defects: Per fect &Imperfect crystals, point defects, Interstitial, Schottky defect, Frenkel defect, line defect & other entities, thermodynamics of Schottky & Frankel defects. Dissociation, theory of dislocation, plane defects- Lineage boundary, grain boundary, stacking fault, 3D defects, Defects & their concentrations, ionic conductivity in solids, Non stoichiometric compounds. Electronicproperties of Non-stoichiometric oxides.

Unit-III 15h

Glasses, Ceramics and composite:Glasses, Ceramics Composites and Nano-materials: Glassy state, glass formers and GlassModifiers. Glasses, Ceramics, Clay products, Refractories with reference to: preparation, Properties and applications. Microscopic composites, dispersion, strengtheried and particlereinforced, fibre reinforced Composites, microscopic composites, nanocrystaline phase, preparation procedure, special properties and applications.

Unit-IV

15 h

Liquid Crystals: Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematics & smectic mesophases; smectic-Nematic transition clearing temperature-homeotrpic, planer & schlieren textures twisted nematics, chiral nematics, molecular arrngement insmectic A & smectic C phases, optical properties of liquid crystals. Dielectric susceptibility & dielectric constants. Lyotropic phases & their description of ordering in liquid crystals.

List of Books:

1. Akhmetov, N.: General and Inorganic Chemistry.
2. Aylett, B. and Smith, B.: Problems in Inorganic Chemistry, (English University Press)
3. Bertini, et al: Bioinorganic Chemistry (Viva)
4. Charlot, G and Bezier, D.: Quantitative Inorganic Analysis (johnWiley).

5. Douglas, B. E. McDanirl, D. H. et al: Concept and Models of Inorganic Chemistry (4th edt.) J. Wiley
6. Dutt P. K.: General and Inorganic Chemistry.(Sarat Books House)
7. Fenton, David E.: Biocoordination chemistry, Oxford
8. Jolly, W. L. : Inorganic Chemistry (4th edn.) Addison-Wesley.
9. Katakis, D. and Gordon, G.: Mechanism of Inorganic Reactions.(J.Wiley).
10. Peter J. Collings, Liquid Crystals-Nature's delicate Phase of Matter, New Age International.
11. S. Chandrasekhar, Liquid Crystals, Cambidge University Press.

Semester III

Practical-V (Code: 3P1)

Inorganic Chemistry Special

12 h /week Marks: 100

A INSTRUMENTAL METHODS

I pH METRY:

1. Stepwise proton ligand and metal ligand constant of complexes by Irving Rossetti method

II COLORIMETRY AND SPECTROPHOTOMETRY

1. simultaneous determination of manganese (KMnO$_4$) and chromium ($K_2Cr_2O_7$)
2. simultaneous determination of cobalt (II) and nickel(II)
3. Determination of composition and stability constant of complexes by Job's method of continuous variation , mole ratio method and slope ratio method

III POTENTIOMETRY

1. Estimation of halide in a mixture by potentiometry
2. Determination of stepwise stability constant of silver thiosulphate complex by potentiometrically

IV CONDUCTOMETRY

1. Estimation of amount of acid in a mixture by conductometric titration

B INORGANIC REACTION MECHANISM

Kinetics and mechanism of following reactions:

1. Substitution reactions in octahedral complexes (acid/base hydrolysis)
2. Redox reactions in octahedral complexes
3. Isomerization reaction of octahedral complexes

C BIOINORGANIC CHEMISTRY (CHLOROPHYLL

1. Extraction and absorption spectral study of chlorophyll from green leaves of student choice
2. separation of chlorophyll and their electronic spectral studies
3. Complexation study of metal ions with biologically important amino acids

List of Books

1. Day And Underwood :Quantitative Analysis
2. Vogel A : A Textbook Of Quantitative Inorganic Analysis, Longman
3. Flaschka : Edta Titration
4. Merits And Thomas:Advanced Analytical Chemistry
5. Ewing, G. W. : Instrumental Methods Of Chemical Analysis, Mcgraw-Hill
6. Drago, R.S:Physical Methoods In Inorganic Chemistry
7. Christain G.D:Analytical Chemistry
8. Khopkar S.M.:Basic Concept Of Analytical Chemistry
9. Koltath And Ligane:Polorography

10. Braun:Instrumental Methods Of Chemical Analysis
11. Willard, Merritt And Dean: Instrumental Methods Of Chemical Analysis ,Van Nostrand
12. Strouts,Crifi;Llan And Wisin: Analytiacl Chemistry
13. Skoog S.A. And West D. W.:Fundamental Of Analytical Chemistry
14. Dilts R.V.: Analytiacl Chemistry
15. Jahgirdar D.V :Experiments In Chemistry
16. Chondhekar T.K: Systematic Experiments In Physical Chemistry, Rajbog S.W., Aniali Pubn.
17. Wlehov G. J: Standard Methods Of Chemicalanalysis 6th Ed
18. Ramesh Rand Anbu M , Chemical Methods For Envirnmental Analysis : Watewr And Sedient , Macmillion India
19. Akjmetov, N :General And Inorganic Chemistry
20. Aylett, B. And Smith , B. :Problems In Inorganic Chemistry
21. Charlot, G. And Bezier, D.: Quantitative Inorganic Analysis (John Wilry)
22. Douglas, B. E. Mcdanirl, D. H. Et Al : Concept Amd Models Of Inorganic Chemistry (4th Ed) J Wiley
23. Dutt P. K.:General And Inorganic Chemistry (Sarat Book House)
24. Fenton, David E.:Biocoordination Chemistry, Oxford
25. Jolly, W. L. :Inorganic Chemistryu (4 Th Ed) Addison-Wesley
26. Bertini, Et Al:Bioinorganic Chemistry (Viva)
27. Katakis, D. And Gordon, G :Mechanism Of Inorganic Reactions (J. Wiley)

Semester III

ORGANIC CHEMISTRY SPECIALIZATION

Paper IX (Code: 3T1)

Special I-Organic Chemistry

60h (4h/week) 15h/ unit 80 Marks

UnitI: Photochemistry 15 h

Interaction of radiation with matter, types of excitation, rate of excited molecules, quenching, Quantum efficiency, quantum yield, transfer of excitation energy, singlet and triplet states, experimental methods in photochemistry of carbonyl compounds, and transition, Norrish type I and Norrish type II reactions Paterno–Buchi reaction, Photoreduction, Photochemistry of enones, Hydrogen abstraction rearrangement of unsaturated ketones and cyclohexadienones, Photochemistry of parabenzoquinones, photochemistry of Aromatic compounds with reference to isomerisation additon and substitution Photochemical isomerization of cis and trans alkenes, Photochemical cyclization of reaction, Photo-Fries rearrangement, di-pi methane rearrangement, Photo theory reaction of anilides, photochemistry of vision, Applications of photochemical methods in synthesis: Isocomene, Cedrene, Hirsutene

Unit II: Pericyclic Reactions 15 h

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1, 3, 5-hexatriene, allyl system, classification of pericyclic reaction. FMO approach, Woodward-Hoffman correlation diagram method and Perturbation of Molecular Orbital (PMO) approach of pericyclic reaction under thermal and photochemical conditions Electrocyclic reactions, conrotatary and disrotatary motion 4n and (4n+2) systems, Cycloaddition reaction with more emphasis on [2+2] and [4+2], Cycloaddition of ketones Secondary effects in [4+2] cycloaddition. Stereochemical effects and effect of substituents on rate of cycloaddition reaction, Diels-Alder reaction, 1,3-dipolar cycloaddition and chelotropic reaction. Sigmotropic rearrangement, suprafacial, and antarafacial shift involving carbon moieties, retention and inversion of configuration, [3,3] and [3,5] sigmotropic rearrangements, Claisen, Cope, Sommelet-Hauser rearrangements, Ene reaction.

Unit III 15 h

A] Oxidation: Oxidation of alkanes, aromatic hydrocarbons and alkenes, Dehydrogenation with S, Se, Fremy's salt, DDQ, chloranil and $PhI(OAc)_2$, Oxidation with SeO_2, Epoxidation of olefins, Synthetic

application of epoxides, Sharpless asymmetric epoxidation, Dihydroxylation of olefins using $KMnO_4$, OsO_4, Woodward and Prevost dihydroxylation, Oxidative cleavage of olefins, Ozonolysis

a) Oxidation of alcohols: Chromium reagents, pyridinium chlorochromate (PCC), pyridinium dichromate (PDC), Collin and Jones reagent, Combination of DMSO with DCC, $(COCl)_2$, NCS and $(CH_3CO)_2O$ for oxidation of alcohols, Oxidation with MnO_2, Oppenauer oxidation
b) Oxidation of aldehydes and ketones, Conversion of ketones to α, β-unsaturated ketones and α-hydroxy ketones, Baeyer-Villiger oxidation , Chemistry and synthetic applications of $Pb(OAc)_4$, Dess-Martin periiodinane, IBX

B**]** Reduction**:** Catalytic heterogeneous and homogeneous hydrogenation, Hydrogenation of alkenes, alkynes and arenes, Selectivity of reduction, Mechanism and stereochemistry of reduction, Raney Ni-catalyst, Adam catalyst, Lindlar catalyst, Wilkinson catalyst.

a) Reduction by dissolving metals, Reduction of carbonyl compounds, conjugated systems, aromatic compounds and alkynes. Birch reduction, Hydrogenolysis
b) Reduction by hydride transfer reagents, Meerwein-Pondorff-Verley reduction, Reduction with $LiAlH_4$ and $NaBH_4$, stereochemical aspects of hydride addition, Derivatives of $LiAlH_4$ and $NaBH_4$, Selectivity issues, Diisobutylaluminium hydride (DIBAL-H), Sodium cyanoborohydride, Reduction with boranes and derivatives Reduction with Bu_3SnH., Reduction of carbonyl group to methylene, Reduction with diimide and trialkylsilanes

Unit IV**:** Chemistry of P, S, Si,and Boron compounds 15 h

a) Phosphours and sulphur ylide: Preperation and their synthetic application along with stereochemistry
b) Umpolung concept: Dipole inversion, generation of acyl anion, use of 1,3-dithiane, ethylmethylthiomethylsulphoxide, bis-phenylthiomethane, metallated enol ethers, alkylidene dithiane, ketone thioacetals, 2-propenethiobismethyl thioallyl anion, thiamine hydrochloride based generation of acyl anion
c) Organoboranes- preparation and properties of organoborane reagents e.g. RBH_2, R_2BH, R_3B, 9-BBN, catechol borane. Thexyl borane, cyclohexyl borane, $ICPBH_2$, IPC_2BH, Hydrboration-mechanism, stereo and regeoselectivity, uses in synthesis of primary, secondary tertiary alcohols, aldehydes, ketones, alkenes, Synthesis of EE, EZ, ZZ dienes and alkyenes. Mechanism of addition of IPC_2BH. Allyl boranes- synthesis, mechanism and uses
d) Organo silicon compounds in organic synthesis, Me_3SiCl, Me_3SiH and Paterson synthesis

List of books

1] Books as suggested in Semester I for organic chemistry
2] Organic Synthesis, The disconnection approach-S. Warren
3] Designing Organic Synthesis-S. Warren
4] Some Modern Methods of Organic Synthesis-W. Carruthers
5] Advance Organic Chemistry Part-B-F. A. Caray and R. J. Sundberg Plenum Press
6] Protective Group in Organic Synthesis-T. W. Greene and PGM
7] The Chemistry of Organo Phosphorous-A. J. Kirbi and S.G. Warren
8] Organo Silicon Compound-C. Eabon
9] Organic Synthesis via Boranes-H. C. Brown
10] Organo Borane Chemistry-T. P. Onak
11] Organic Chemistry of Boron-W. Gerrard
12] Fundamentals of Photochemistry-K. K. Rohatgi-Mukharji, Wiley Eastern Limited
13] Photochemistry-Cundau and Gilbert
14] Aspects of Organic Photochemistry-W. M. Horspoot
15] Photochemistry-J. D. Calvert
16] Photochemistry-R. P. Wayne

Semester III
Paper X (Code: 3T2)
SpecialII-Organic Chemistry

60h (4h/week) 15h/ unit 80 Marks

Unit – I

15 h

A] Terpenoids: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, and synthesis of the following representative molecules: Citral, Geraniol, α-terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β-carotene, Vitamin A Genesis of biological isoprene unit, Biosynthesis (ONLY) of the following tepenoids: myrecene, linalool, geraniol, α-terpeneol, limonene, camphor, α-pinene, β-pinene, farnesol, β-bisabolene and squelene

B] Porphyrins: Structure and synthesis of Haemoglobin and Chlorophyll

Unit II 15 h

A] Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants Structure, stereochemistry, and synthesis of the following: Ephedrine, (+)-coniine, Nicotine, Atropine, Quinine, Reserpine and Morphine,
Biosynthesis (ONLY) of the followings: hygrine, tropinone, nicotine, pelletierine, conine

B] Prostaglandins: Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE_2 and $PGF_{2\alpha}$

Unit-III 15 h

A] Steroids: Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone and Aldosterone.
Biosynthesis of steroids (lanosterol)

B] Plant Pigments: Occurrence, nomenclature and general methods of structure determination, isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin, Quercetin-3-glucoside, Vitexin, Diadzein, Butein, Cyanidin-7-arabinoside, Cyanidin, Hirsutidin.
Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway

Unit IV: 15 h

A] Carbohydrate: Types of naturally occurring sugars, deoxy sugars, amino sugars, branched chain sugars, methyl ethers and acid derivatives of sugars, general methods of structure and ring size determination with reference to maltose, lactose, sucrose, Chemistry of starch and cellulose.

B] Amino acids, protein and peptides: Amino acids, structural characteristics, acid base property, stereochemistry of amino acids, optical resolution, Stecker synthesis, peptide and proteins structure of peptide and protein, primary, secondary, tertiary and quaternary structure. Reaction of polypeptide, structure determination of polypeptide, Solid phase peptide synthesis, end group analysis.

List of books

1] Chemistry of Alkloids-S. W. Pelletier
2] Chemistry of Steroids-L. F. Fisher and M. Fisher
3] The Molecules of Nature-J. B. Hendricsion
4] Biogenesis of Natural Compound - Benfield
5] Natural Product Chemistry and Biological Significance- J. Mann, R. S Devison, J. B. Hobbs, D. V. Banthripde and J. B. Horborne
6] Introduction to Flavonoids-B. A. Bohm, Harwood
7] Chemistry of Naturally Occurring Quinines-R. H. Thomson
8] The Systematic Identification of Flavonoids- Marby, Markham, and Thomos

9] Text Book of Organic Medicinal Chemistry-Wilson, Geswold
10] Medicinal Chemistry Vol I and II-Burger
11] Synthetic Organic Chemistry -Gurudeep Chatwal.
12] Organic Chemistry of Natural Products Vol I and II-O. P. Agrawal
13] Organic Chemistry of Natural Products -Gurudeep Chatwal
14] A Textbook of Pharmaceutical Chemistry-Jayshree Ghosh
15] Synthetic Dyes Series -Venkatraman
16] Chemistry Process Industries-Shreve and Brink
17] Principal of Modern Heterocyclic Chemistry-L. A. Paquelte
18] Heterocyclic Chemistry-J. Joule and G. Smith
19] Heterocyclic Chemistry-Morton
20] An Introduction to Chemistry of Heterocyclic Compound-J. B. Acheson
21] Introduction to Medicinal Chemistry-A. Gringuadge
22] Wilson and Gisvold Text Book of Organic Medicinal and Pharmaceutical Chemistry-Ed. Robert F Dorge
23] An Introduction to Drug Design-S. S. Pandey and J. R. Demmock
24] Polymer Science-V. Govarikar
25] Principle of Polymer Chemistry-P. J. Flory
26] An Outline of Polymer Chemistry-James Q. Allen
27] Organic Polymer Chemistry-K. J. Saunders

Semester III

Practical-V (Code: 3P1)
Organic Chemistry Special)

12 h /week Marks: 100

[A**]** Quantitative Analysis

Student is expected to carry out following estimations (minimum 6 estimations.)

1. Estimation of Vitamin "C" Iodometry.
2. Estimation of Phenol by $KBrO_3$-KBr.
3. Estimation of Amine by Bromate/ Bromide solution.
4. Estimation of Formaldyde by Iodometry.
5. Estimation of Glucose by Benedict's solution.
6. Estimation of given carbonyl compound by hydrazone formation.
7. Estimation of Aldehyde by Oxidation method.
8. Determination of percentage of number of hydroxyl group in an organic compound by acetylation method.

[B**]** Isolation of Organic Compounds from Natural Source **(**Any six**)**

a) Isolation of caffeine from tea leaves.
b) Isolation of casein from milk (the students are required to try some typical colour reactions of proteins)
c) Isolation of lactose from milk (purity of sugar should be checked by TLC and PC and Rf value reported.)
d) Isolation of nicotine dipicrate from tobacco
e) Isolation of cinchonine from cinchona bark
f) Isolation of piperine from black pepper
g) Isolation of lycopene from tomatoes
h) Isolation of β-carotene from carrots
i) Isolation of cysteine from hair
j) Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid
k) Isolation of eugenol from cloves

l) Isolation of (+) limonine from citrus rinds

[C**]** QUALITATIVE ANALYSIS

Separation of the components of a mixture of three organic compounds (three solids, two solids and one liquid, two liquids and one solid, all three liquids and identification of any two components using chemical methods or physical techniques. Minimum 10-12 mixtures to be analyzed.

Semester III

PHYSICAL CHEMISTRY SPECIALIZATION

Paper IX **(**Code**:** 3T1**)**

Special I**-**Physical Chemistry

60h *(*4h/week*)* 15h/unit 80 Marks

UNIT I **:** STATISTICAL THERMODYNAMICS 15h

A**]** Statistical thermodynamics**:** Atomic and Molecular quantum levels, Significance of Boltzmann Distribution law, partition Functions and ensembles, ensemble averaging, postulates of ensemble averaging, canonical, grand canonical and micro canonical ensembles, corresponding distribution laws using Lagranges method of undetermined multipliers*. Ortho and para hydrogen, principle of equipartition of energy, calculation of average energy*

B**]** Partition function, Translational partition function, Rotational partition function, Vibrational partition function, Electronic partition function, Applications of partition functions, Numericals**.**

UNIT II**:** ELECTROCHEMISTRY OF INTERFACES 15h

A**]** Electrode Interfaces**:** Quantum aspects of charge transfer at electrode**-**solution interfaces, quantization of charge transfer, tunneling**.** Semiconductor interfaces**:** Theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces, effect of light at semiconductor solution interface**.**

B**]** Electro catalysis**:** Comparison of electro catalytic activity, importance of oxygen reduction and hydrogen evolution reactions, and their mechanism, volcanoes**.**

C**]** Bio**-**electrochemistry**:** Threshold membrane phenomena, Nernst Plank equation, Hodges Huxley equations, core conductor models, electrocardiography**.**

UNIT III**:** CHEMICAL DYNAMICS **-** I 15h

A**]** Dynamics of complex reactions**:** reversible, parallel, consecutive, concurrent and branching reactions, free radical and chain reactions, reaction between Hydrogen **–** Bromine and Hydrogen **–** Chlorine **(**thermal and photochemical**)**, decomposition of ethane, acetaldehyde, N_2O_5, Rice Herzfeld mechanism, Oscillatory autocatalytic and Belousov**-**Zhabotinsky reactions**.**

B**]** Fast Reactions**:** relaxation methods, flow methods, flash photolysis, magnetic resonance method, relaxation time and numericals**.**

UNIT IV**:** PHOTOCHEMISTRY 15h

A**]** Photophysical phenomenon**:** Introduction, photo and photochemical excitation and de**-**excitation, fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching**:** concentration quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photoexcited donor and acceptor systems**.** Stern**-**Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and analytical significance, bimolecular collisions, quenching and Stern**-**Volmer equation**.**

B**]** Photochemical reactions**:** photoreduction, photooxidation, photodimerization, photochemical substitution, photoisomerization, photosenitisation, chemiluminescence, photochemistry of environment**:** Green house effect**.**

List of books:
1. G. M. Panchenkov and V. P. Labadev, " Chemical Kinetics and catalysis", MIR Publishing
2. E.A. Moelwyn- Hughes, "Chemical Kinetics and Kinetics of Solutions", Academic
3. K. J. Laidler, Chemical Kinetics, Third Edition (1987), Harper and Row, New York
4. J. Raja Ram and J. C. Kuriacose, Kinetics and Mechanism of Chemical Transformations MacMilllan Indian Ltd., New Delhi (1993)
5. J.G. Calvert and J.N. Pitts, Jr., *Photochemistry,* John Wiley and Sons, New York (1966).
6. K. K. Rohtagi-Mukherjee, *Fundamentals of Photochemistry,* New Age International, New Delhi(1986).
7. R. P. Wayne, *Principles and Applications of Photochemistry,* Oxford University Press, Oxford(1988).
8. N. J. Turro, *Modern Molecular Photochemistry,* Univ. Science Books, Sansalito (1991).
9. J. F. L. Lakowicz, *Principles of Fluorescence Spectroscopy,* 2nd Edition (1999), PlenumPublishers, NewYork.
10. F.W.Sears, " Introdction to Thermodynamics, Kinetic Theory of Gases and statistical mechanics".AddisonWesley
11. H. K. Moudgil, Text Book of Physical Chemistry, Pretice Hall of India, New Delhi, 2010.
12. M. C. Day and J Selbin, Theoretical Inorganic Chemistry, Reinhold Pub. Corp., New York,
13. N. J. Turro, V. Ramamurthy and J. C. Scaiano, Principles of Photochemistry – An Introduction, Viva Books, New Delhi, 2015.
14. G. A. Somorjai, Introduction to Surface Chemistry and Catalysis, Wiley, 2010.
15. M. C. Gupta, Statistical Thermodynamics, New Age International.
16. K. Huang, Statistical Mechanics, Wiley, New Delhi, 2003.
17. Andrew Maczek, *Statistical Thermodynamics,* Oxford University Press Inc., New York (1998).
18. B. K. Agarwal and M. Eisner, *Statistical Mechanics*, Wiley Eastern, New Delhi (1988).
19. D. A. McQuarrie, *Statistical mechanics*, Harper and Row Publishers, New York (1976).
20. J.O.M.Bokris and A.K.N.Reddy, "Modern Elcrtrochemistry". Wiley
21. S. Glasstone, "Introduction to Electrochemistry" Affilisated East West Press, New Delhi.
22. D. R. Crow, " The Principle of electrochemistry", Chapman Hall
23. G. K. Agrawal, Basic Chemical Kinetics, Tata-Mc-Graw Hill Pvt., Ltd. 1990
24. K. L. Kapoor, Text Book of Physical Chemistry, Vol – I to Vol-VI, 2011.

Semester III

Paper X (Code: 3T2)

Special II-Physical Chemistry

60h *(4h/week)* 15h/unit 80 Marks

UNIT-I: QUANTUM MECHANICS - II 15h

A] Applications of Quantum Mechanics: Approximate methods, variation principle, its application in Linear and non-linear functions, MO theory applied to H_2^+ molecule and H_2 molecule (calculation of energy), perturbation theory, application of perturbation theory to helium atom, generation of the concept of resonance.

B] Electronic structure of atoms: Russel Sanders terms and coupling schemes, Slater determinents, term separation energies of the p^n configuration, term separation energies for d^n configuration, magnetic effects: spin orbit coupling and Zeeman splitting.

C] Hybridization, hybrid orbitals in terms of wave functions of s and p orbitals, sp and sp^2 hybridizations, Simple Hückel theory applied to: ethylene, butadiene, cyclobutadiene, cyclopropenyl radical.

Unit II: SOLID STATE REACTIONS AND NANOPARTICLES 15h

A] Solid State Reactions: General principle, types of reactions: Additive, decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the solid state reactions. photographic process.

B] Nanoparticles and Nanostructural materials: Introduction, methods of preparation, physical properties, and chemical properties, sol-gel chemistry of metal alkoxide, application of Nanoparticles, Charecterization of Nanoparticles by SEM and TEM. Nanoporous Materials: Introduction, Zeolites and molecular sieves, determination of surface acidity, porous lamellar solids, composition-structure, preparation and applications.

UNIT-III: ELECTROCHEMISTRY OF SOLUTION 15h

A] Metal/Electrolyte interface: OHP and IHP, potential profile across double layer region, potential difference across electrified interface; Structure of the double layer : Helmholtz-Perrin, Gouy Chapman model, Stern region, Graham Devanathan- Mottwatts, Tobin, Bockris, Devnathan Models.

B] Over potentials, exchange current density, derivation of Butler Volmer equation under near equilibrium and non-equilibrium conditions, Tafel plot

C] Electrical double lever, theories of double layer, electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.

UNIT IV: IRREVERSIBLE THERMODYNAMICS 15h

A] Microscopic reversibility and Onsager reciprocity relation, phenomenological equations, Transformation of generalized fluxes and forces. The cyclic version of Clausius' inequality and its integrated form and their correspondence with time's arrow and irreversibility, Clausius' uncompensated heat. Derivation of the differential form of Clausius' inequality.

B] Rate of entropy production and the concept of Chemical affinity and its application to the cases of chemical reactions, coupled reactions, electrochemical reactions. Derivation of Gibbs relation and its DeDonderian version (time rate form) for spatially uniform chemically reacting closed systems, entropy production in spatially non-uniform systems like heat flow, Electrokinetic effect – Saxen relation.

List of books:

1. Ira .N. Levine, Quantum Chemistry, 5th edition(2000), Pearson educ., Inc.New Delhi
2. A.K.Chandra, Introductory Quantum Chemistry, 4th edition (1994), Tata Mcgraw Hill, New Delhi.
3. M.W.Hanna, " Quantum Mechanics in Chemistry", Benjamin
4. L. Pualing and E. B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry, McGraw Hill, New York (1935).
5. R. K. Prasad, Quantum Chemistry, New Age International, Delhi.
6. R. K. Prasad, Quantum Chemistry through problems and solutions, New Age International, New Delhi, 2009.
7. B. C. Reed, Quantum Mechanics, Jones and Bartlett, New Delhi, 2010.
8. S. Glasstone, An Introduction to Electrochemistry, East-West Press Pvt. Ltd., New Delhi, 2004.
9. D. Mcquarie and J. Simon, Physical Chemistry – A Molecular Approach, University Press, 2000
10. H. K. Moudgil, Text Book of Physical Chemistry, Pretice Hall of India, New Delhi, 2010.
11. S. O. Pillai, Solid State Physics, New Age International, New Delhi, 2102.
12. M. C. Day and J Selbin, Theoretical Inorganic Chemistry, Reinhold Pub. Corp., New York,
13. I Prigogine and R. Defay, Chemical Thermodynamics, Longmans, London, 1954.
14. S. R. DeGroot and P. Mazoor, Non-Equilibrium Thermodynamics, North-Holland Co., Amsterdam, 1969.
15. G. Lebon, D. Jou and Casa Vazquez, Understanding Non-equilibrium Thermodynamics, Springer, 2008.
16. I.Prigoggine, "An Introduction to Thermodynamics of Irreversible Processes," Wiley-Interscience.
17. R. P. Rastogi, Introduction to Non-equilibrium Physical Chemistry, Elsevier, Amsterdam, 2008.
18. J.O.M.Bokris and A.K.N.Reddy, "Modern Elcrtrochemistry". Wiley
19. S. Glasstone, "Introduction to Electrochemistry" Affilisated East West Press, New Delhi.
20. D. R. Crow, " The Principle of electrochemistry", Chapman Hall

21. C.Kittel, " Introduction to solid state Physics",Wiley
22. L.V.Azaroff, " Introduction to solids", McGraw Hill
23. Santosh Kumar Upadhyay, Chemical Kinetics and Reaction Dynamics, Springer 2006.
24. N. B. Hanny, Treaties in Solid State Chemistry, 4th Edn,
25. N. B. Hanny, Solids,
26. Sulbha Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing House, 2011.
27. T. Pradeep, Nano: The Essentials, Tata Mc-Graw Hill, 2012
28. K. L. Kapoor, Text Book of Physical Chemistry, Vol – I to Vol-VI, 2011.
29. N. B. Hanny, "Solid State Chemistry"
30. C. N. R. Rao and Gopalakrishnan, "New Directions in Solid State Chemistry " Second Edition, Cambridge University Press.
31. Anthony R. West, "Solid State Chemistry and its Applications" Wiley India Edition.

Semester III

Practical-V (Code: 3P1)

Physical Chemistry Special

12 h /week Marks: 100

Thermodynamics:

1. Determination of partial molar volume of solute and solvent (ethanol-water, methanol-water, KCl-water mixture)

Solutions:

2. Study the variation of solubility of potassium hydrogen tartarate with ionic strength using a salt having a common ion and hence determine the mean ionic activity coefficients.
3. Determination of temp. dependence of the solubility of a compound in two solvents having similar intermolecular interactions(benzoic acid in water and DMSO – water mixture) and calculation of the partial molar heat of solution.

Phase equilibrium:

4. To study the effect of addition of an electrolyte such as NaCl, KCl,Na_2SO_4,K_2SO_4 etc. on the solubility of an organic acid(benzoic acid or salicylic acid).
5. To determine the heat of crystallization of $CuSO_4$,$5H_2O$
6. To determine the heat of reaction involving precipitation of a salt $BaSO_4$
7. To determine transition temperature of $CaCl_2$ by thermometric method and to determine transition temperature of $CaCl_2$, sodium bromide by solubility method

Kinetics:

8. To determine the activation energy of hydrolysis of an ester by acid.
9. Kinetics of reaction between sodium thiosulphate and KI. Determination of rate constant; study of influence of ionic strength
10. Kinetics of decomposition of H_2O_2 catalysed by iodide ion. Also determination of activation energy of reaction.

Conductometry:

11. Estimate the concentration of H_2SO_4, CH_3COOH, $CuSO_4.5H_2O$ in a given solution by carrying out conductometric titration against NaOH solution.
12. Determine the eq. conductance of strong electrolyte (KCl, NaCl, HCl, KNO_3) at several concentration and hence verify Onsager's equation.
13. Carry out the following precipitation titration conductometrically. a. 50 ml.0.02N $AgNO_3$ with 1N HCl; b.50 ml.0.02N $AgNO_3$ with 1N KCl; c. 50 ml 0.004 N $MgSO_4$ with 0.1 N Ba$(OH)_2$; d. 50 ml 0.002 N $BaCl_2$ with 1 N Li_2SO_4; e. 50 ml.0.02 N $BaCl_2$ with 1N K_2SO_4

Potentiometry:

14. To prepare calomel electrode and to determine the potential of calomel electrode by potentiometry.

15. To determine stability constant of Fe^{3+} with potassium dichromate in presence of dilute sulphuric acid by redox titration.
16. To determine solubility product of Silver chloride by potentiometric method.
17. Determination of redox potential of the couples(Fe^{2+}/Fe^{3+},Co^{3+}/Co^{2+},Cr^{3+}/Cr^{2+},MnO_4^-/Mn2+(any two) and equilibrium constant.
18. Study of complex formation by potentiometry e.g.Ag^+-$S_2O_3^{-2}$, Fe^{3+}-SCN^-,Ag^+-NH_3(any two) and calculation of stability constant.

Spectrophotometry:

19. To verify Beers law for solution of potassium permanganate and to find molar extinction coefficient.
20. To determine the indicator constant (pK_{In}) of methyl orange/red spectrophotometrically.

Polarography:

1. Determination of the half-wave potential of the cadmium ion in 1M potassium chloride solution.
2. Investigation of the influence of dissolved oxygen.
3. Determination of cadmium in solution.
4. Determination of lead and copper in steel.

List of Books

1. Vogel A : A Textbook Of Quantitative Inorganic Analysis, Longman
2. Das and Behra, Practical Physical Chemistry
3. Carl W. Garland, Joseph W. Nibler and David P. Shoemaker, Experiments in Physical Chemistry, Mc-Graw Hill, 8th Edition, 2009.
4. Farrington Daniels, Joseph Howard Mathews, John Warren Williams, Paul Bender, Robert A. Alberty, Experimental Physical Chemistry, Mc-Graw Hill, Fifth Edition, 1956.
5. John W. Shriver and Michael George, Experimental Physical Chemistry, Lab Manual and Data Analysis, The University of Alabama in Huntsville, Fall 2006
6. Day And Underwood :Quantitative Analysis
7. Merits And Thomas:Advanced Analytical Chemistry
8. Ewing, G. W. : Instrumental Methods of Chemical Analysis, Mcgraw-Hill
9. Drago, R.S:Physical Methoods In Inorganic Chemistry
10. Christain G.D:Analytical Chemistry
11. Khopkar S.M.:Basic Concept Of Analytical Chemistry
12. Koltath And Ligane:Polorography
13. Braun:Instrumental Methods Of Chemical Analysis
14. Willard, Merritt And Dean: Instrumental Methods Of Chemical Analysis ,Van Nostrand
15. Strouts,Crifi;Llan And Wisin: Analytiacl Chemistry
16. Skoog S.A. And West D. W.:Fundamental of Analytical Chemistry
17. Dilts R.V.: Analytiacl Chemistry
18. Jahgirdar D.V :Experiments In Chemistry
19. Chondhekar T.K: Systematic Experiments In Physical Chemistry, Rajbog S.W., Aniali Pubn.
20. Wlehov G. J: Standard Methods Of Chemicalanalysis 6th Ed

Semester III

ANALYTICAL CHEMISTRY SPECIALIZATION

Paper IX(Code: 3T1)

Special I-Analytical Chemistry

60h (4h/week) 15h/unit 80 Marks

Unit-I: Radioanalytical Chemistry-I 15h

Radioactivity-Radiation-Units-Curie, Becquerel, Gray, Rad, Sievert, RBE, REM, Half life, mixed half life, branching decay, different types of radiations and their interactions with matter, radioactive

equilibrium, Elementary principles of GM and proportional counters, Gamma Ray Spectrometer, Ionization chamber, HPGe detector, NaI(Tl) detector, calibration using standard sources, resolution, numericals.

Unit-II:Optical methods of analysis-III 15h

Atomic absorption spectroscopy: Principle. Atomic energy levels. Grotrian diagrams. Population of energy levels. Instrumentation. Sources: Hollow cathode lamp and electrodeless discharge lamp, factors affecting spectral width. Atomizers: Flame atomizers, graphite rod and graphite furnace. Cold vapour and hydride generation techniques. Factors affecting atomization efficiency, flame profile. Monochromators and detectors. Beam modulation. Detection limit and sensitivity. Interferences and their removal. Comparison of AAS and flame emission spectrometry. Applications of AAS.

Unit-III: Electrochemical methods of analysis-III 15h

Stripping Voltammetry: Principle and technique in anodic and cathodic stripping voltammetry, applications to metal ion analysis, limitations.

Adsorptive stripping voltammetry: Principle, technique, applications to metal ions and organic analysis. Advantages over anodic stripping voltammetry. Catalytic effects in voltammetry.

Working electrodes: Mercury electrodes, carbon electrodes, film electrodes.

Cyclic voltammetry: Principle and technique. Randles-Sevcik equation. Interpretation of voltammogram- reversible, irreversible and quasi-reversible systems. Applications of cyclic voltammetry in study of reaction mechanism and adsorption processes.

Electrochemical sensors (Chemically modified electrodes): Biosensors, catalytic sensors and gas sensors.Comparison of voltammetry with AAS and ICP-AES.

Unit-IV: Miscellaneous techniques-I 15h

Fluorometry and phosphorimetry: Principles of fluorescence and phosphorescence. Jablonski diagram. Concentration dependence of fluorescence intensity. Fluorescence quenching. Instrumentation. Applications.

Nephelometry and turbidimetry: Principle, instrumentation and applications.

*Photoacoustic spectroscopy:*Theory. Instrumentation. Advantages over absorption spectroscopy. Chemical and surface applications of PAS.

Electrogravimery: Theory of electrolysis. Electrode reactions. Decomposition potential. Overvoltage. Characteristics of deposits and completion of deposition. Instrumentation. Application in separation of metals.

Semester III

Paper X(Code: 3T2)

Special II-Analytical Chemistry

60h *(4h/week)* 15h/unit 80 Marks

Unit-I: Organoanalytical Chemistry 15h

Elemental analysis: Outline of macro, semi-micro, micro and ultra-micro analysis, semi-micro determination of carbon, hydrogen, halogen, sulphur, nitrogen, phosphorous, arsenic, boron and metals in organic compounds.

Functional group analysis: Semi-micro determination of the following functional groups in organic compounds- hydroxyl, amino, nitro, nitroso, azo, N-acetyl, O-acetyl, methyl, aldehydes, ketones, thio, disulphide, sulphonamide, unsaturation and active hydrogen.

KF reagent: Karl Fischer reagent and its use in analysis of water in organic compounds.

Unit-II: Analysis of ores and cement

15h

Ores: Composition and analysis of the followings ores- Bauxite, Pyrolusite, Dolomite, Chromite.
Portland cement: Composition, raw material, manufacturing processes, characteristics, analysis.

Unit III: 15h

Water pollution and analysis: Sources of water pollution, composition of potable water, importance of water analysis, sampling and sample preservation, physico-chemical analysis of water. Mineral analysis (temperature, pH, conductivity, turbidity, solids, alkalinity, chloride, fluoride, sulphates, hardness), Demand analysis (DO, BOD, COD, TOC), nutrients (nitrogen-total, nitrate, nitrite, phosphate) and heavy metals (As, Cd, Cr, Hg and Pb). A brief idea of coagulation and flocculation. Water treatment plants: Sand filters and other types of filters.

Unit-IV: Air pollution and analysis 15h

Air pollution and analysis-classification of air pollutants, sources of air pollution and methods of control, sampling of aerosols and gaseous pollutants and their effects, SO_2, NO_2, CO, CO_2, particulates-SPM, RSPM, High Volume Sampler, Fabric Filters, Cyclones (direct and Reverse), ESP, ozone layer, Green house effect, Heat Islands, Acid Rain.

List of books:

1. Essentials of Nuclear Chemistry: H. J. Arnikar (Willey Eastern Ltd)
2. Substoichiometry in Radioanalytical Chemistry: J. Ruzicka and J Stary (Pergamon Press)
3. Introduction to Radiation Chemistry: J. W. T. Spinks and R. J. Woods
4. Radiochemistry: A. N. Nesmeyanov (Mir Publications)
5. Instrumental Methods of Analysis: Willard, Meriit and Dean(Van Nostrand)
6. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
7. Vogel's Text Book of Quantitative Inorganic Analysis: Bassett, Denney, Jeffery and Mendham (ELBS)
8. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
9. Atomic Absorption Spectroscopy: Robinson (Marcol Dekker)
10. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
11. Analysis of Water: Rodier
12. Laboratory manual of water analysis: Moghe and Ramteke (NEERI)
13. Electroanalytical chemistry: Joseph Wang
14. Electroanalytical stripping methods: Brainina and Neyman (Wiley-Interscience)
15. Trace analysis: S. Lahiri (Narosa Publishing House)
16. Electroanalytical Chemistry: Bard (Marcel-Dekker)
17. Chemistry in Engineering and Technology- Vol I and II: J.C. Kuriacose and J. Rajaram (Tata-McGraw Hill)

Semester III

Practical-V (Code: 3P1)

Analytical Chemistry Special

12 h /week Marks: 100

pH-metry

1. Determination of percent Na_2CO_3 in soda ash by pH-metric titration.
2. Determination of isoelectric point of amino acid.
3. Determination of three dissociation constants of phosphoric acid.

Conductometry

1. Displacement titration of CH_3COONa with HCl.
2. Precipitation titration of $MgSO_4$ and $BaCl_2$.

3. Titration of mixture of CH_3COOH, H_2SO_4 and $CuSO_4$ with NaOH.

Potentiometry

1. Estimation of Cl^-, Br^- and I^- in a mixture.
2. Determination of percent purity of phenol by potentiometric titration with NaOH.
3. Estimation of acids in mixtures.

Coulometry

1. Estimation of nickel and cobalt by coulometric analysis at controlled potential.
2. Analysis of antimony (III) with I_3^- .

Polarography

1. Determination of $E_{1/2}$ of Cd^{2+} and Zn^{2+} at DME.
2. Estimation of Cd^{2+} and Zn^{2+} in respective solutions by calibration curve and standard addition methods.
3. Determination of composition /stability constant of complex.

Cyclic voltammetry

1. Study of cyclic voltammograms of $K_3[Fe(CN)_6]$.

Electrogravimetry

1. Estimation of nickel and copper individually as well as in mixture.

Polarimetry

1. Inversion of cane sugar in the presence of HCl.
2. Determination of percentage of two optically active substances (d-glucose and d-tartaric acid) in mixture.

Colorimetry**/**spectrophotometry

1. Simultaneous determination of chromium and manganese in given mixture.
2. Simultaneous determination of two dyes in a mixture.
3. Estimation of Mn in steel.
4. Estimation of Cu/Ni in alloys.
5. Estimation of iron in water sample using 1,10-phenanthroline.
6. Estimation of Fe(III) in given solution by photometric titration with EDTA (salicylic acid method).

Flame photometry

1. Estimation of Li, Na, K, Ca in rock/ soil / water samples.

Turbidimetry and nephelometry

1. To determine molecular weight of polymer.
2. Estimation of sulphate in water sample by turbidimetry.
3. Estimation of phosphate by nephelometry.

Radioanalytical techniques

1. GM-counter: Plateau, nuclear statistics, half thickness of aluminium absorbers, dead time.
2. Gamma ray spectrometer: Calibration using standard sources, determination of half life (Mn-56, I-128, In-116)
3. Experiments based on radiation chemistry: G-value-$G(NO_2^-)$.

Demonstrations

1. UV-spectrophotometry

Semester III

Paper XI **(**Code**:** 3T3**)**

Elective**-** Nuclear Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Radioactive decay 15h

Various modes of decay, natural radioactivity, successive radioactive decay and growth kinetics, radioactive equilibrium, half life, half life of mixed radioisotopes, decay schemes, its determination by experimental methods, statistical nature of nuclear radiation, treatment of nuclear data and calculation of standard deviation, probability

Unit-II: Nuclear structure 15h

mass-energy relationship, nuclear binding energy, semi-empirical mass formula, nuclear stability rules, nuclear properties, mass size, spin and parity, nature of nuclear forces, liquid drop model, shell model, its evidence and advantages, comparison of the two models, calculations based on above.Energetics of nuclear reaction, cross reaction, comparison with chemical reactions, various types of nuclear reactions, photonuclear, spallation and thermonuclear reaction

Unit-III: Interaction of radiations with matter,detectors 15h

Interaction with matter and detection of gamma rays with matter by photoelectric, Compton and pai production, interaction of beta particles, neutrons and heavy charged particles, various methods of detecting nuclear radiations, gas filled counters, ionization chamber, proportional and GM counters, scintillation detector and solid state detectors- Ge(Li), Si(Li) and HPGe.

Unit-IV: Nuclear fission and Fusion 15h

Probability, mass and charge distribution, release of energy and neutrons, spontaneous fission, nuclear reactors and their uses for power production, brief idea about thermal and fast breeder reactors, reprocessing of nuclear fuel, PUREX process, heavy water- manufacturing and use in reactors. accelerators, nuclear fusion. Production of isotopes by nuclear reactions, production of new elements, radioactive waste management and disposal

Semester III

Practical VI–Elective (Code: 3P3)

Nuclear Chemistry Practical

12 h per week Marks-100

1. Working of GM counter, plateau, statistics, geometry effects, dead time, energy of beta particle, back scattering
2. Working of gas flow proportional counter, plateau, statistics, geometry effects, dead time, energy of beta particle
3. Working with scintillation counter, gamma ray spectra, energy calibration and resolution, half life determination of single and composite nuclei.
4. Radiochemical separation of ^{234}Th from natural uranium salt and its half life determination
5. Experiment on Neutron Activation Analysis by non-destructive method
6. Dose measurement by Fricke and other chemical dosimeters
7. Radiolysis of potassium nitrate, methyl iodide, carbon tetrachloride-iodine systems
8. Szilard-Chalmers reactions with inorganic and organic systems, potassium permanganate and methyl iodide
9. Some trace experiments like partition coefficient, solubility product, isotopic exchange, isotope dilution analysis, radiochromatography, ion exchange.

List of books:

1. H. J. Arnikar - Essentials of Nuclear Chemistry (Willey Eastern Ltd)
2. G. Friendlander, J. W. Kennedy,E. S. Macias and J. M. Miller-Nuclear and Radiochemistry (Wiley Intersciences, New York)
3. G. R. Choppin and J. Rydberg- Nuclear Chemistry-Principles and Applications(Pergamon press, London)
4. B. G. Harvey-Introduction to Nuclear Physics and Chemistry(Prentice Hall of India)

A. N. Nesmeyanov - Radiochemistry- (Mir Publications)

5. M. N. Sastry-Introduction to Nuclear Science, Affiliated East-West Press, New Delhi
6. G. Hughes- Radiation Chemistry- Oxford University Press, London

7. V. Verschinskii and A. K. Pikeav-Introduction to Radiation Chemistry, Israel Publication, Jerusalem-Robinson (Marcol Dekker)
8. Farhat Aziz and M. A. J. Radgers-Radiation Chemistry-Principles and Applications, VCH Publishers FRC.
9. M. Hassinsky-Nuclear Chemistry and its application, Addison Wesley

Semester III

Paper XI (Code: 3T3)

Elective- Environmental Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit -I: Concept and scope of Environmental Chemistry 15 h

Biosphere, Lithosphere, Hydrosphere and Atmosphere, Ecological principles- aspects of ecology, classification,types of ecosystems. Biogeochemical cycles- carbon, nitrogen, phosphorous, oxygen, hydrogen, sulphur, iron, sodium, potassium, magnesium, cobalt, mercury, lead, zinc and cadmium.
Thermal pollution—sources, harmful effects and prevention of thermal pollution.
Noise pollution --- sources, effects and control of noise pollution.

Unit-II: Water 15 h

Origin, physico-chemical properties of water, sources of water, hydrological cycle, criteria ofwater quality, Water management- water shed management, rain water harvesting, waterpollution-sources, consequences and harmful effects of water pollution, strategies for waterpollution control.

Unit-III: Air 15 h

Major regions of the atmosphere, composition of the atmosphere, temperature inversionand air pollution episodes, photochemistry of the atmosphere, depletion of the stratosphericozone, green house effect, green house gases, remedial measures for reversion of green house effect, acid rain, photochemical smog, particulate matter.

Unit-IV: 15 h

Soil: Chemical and mineralogical composition of soil, classification of soil, types of soil- saline and alkaline, physical properties – texture, bulk density, permeability, chemical properties—Ion exchange capacity, soil pH and micro and macro nutrient availability. Soil management—Management of saline and alkaline soil, soil indicator plants,
Radioactive Pollution: Introduction to radiation chemistry, sources of radioactive pollution, effects of radioactivepollution, nuclear disasters in the two decades, protection from radiation, control of radiation.

Semester III

Practical VI–Elective (Code: 3P3)

Environmental Chemistry Practical

12h per week Marks-100

WATER ANALYSIS

1 Sampling of water-tap water, overhead storage tank water, pond water and lake water
2 Physico –chemical and organoleptic characteristics of the above water sample
3 Statistical evolution of the data obtained for optimization of result
4 Determination of total solids, total dissolved solids and total suspended solids and its significance
5 Determination and comparison of chlorine content in tap water, storage tank and swimming pool
6 Determination of acidity and alkalinity in water samples
7 Determination of total, permanent and temporary hardness of water sample
8 Determination of DO, COD, and BOD of water sample

9 Analysis of chemicals used in water and waste water treatment-alum, bleaching powder, activated carbon
10 Analysis iron and manganese in water sample by visual titrimetry
11 Analysis of copper and nickel in water sample by Spectrophotometry
12 Analysis of phenol in water sample by Spectrophotometry
13 Analysis of nitrite in water sample by Spectrophotometry
14 Analysis of chromium in water sample
15 Analysis of chloride in water sample
16 Analysis of sulphate in water sample
17 Determination of turbidity of a given water sample
18 Estimation of Na, K, by flame photometry in given water

AIR ANALYSIS

1 Determination of SOx and NOx and TSPM **(**total suspended particulate matter**)** and RSPM in ambient air

SOIL ANALYSIS

1 Analysis of different types of soil like pH, conductivity, alkalinity etc**.**
2 Determination of N,K, P of soil by flame photometry
3 Analysis of nutrients**-**nitrogen **(**total, ammonia, nitrite & nitrate **)**, phosphate total
4 Determination of macro &micro nutrients in soil

List of books

1. Water analysis : J. Rodier
2. A Text book of Inorganic Analysis : A.I.Vogel
3. Colorimetric Determination of metals : E.B.Sandell
4. Environmental Chemistry : Moore J W and Moore E A. Academic Press, New York, 1976.
5. Environment and Man Vol VII: The Chemical Environment Edited by J Lenihar and W Fleecher Vlackie Publication, 1977.
6. The Chemistry of Environment: R A Horne, Wiley Interscience Publication 1978.
7. Fundamentals of Air Pollution: A C Stern
8. Instrumental Methods of Analysis: Willard,Merrit and Dean
9. Analytical Chemistry: Meites and Thomas
10. Standard Methods for Examination of water and waste water: A E Greenberg, A D Eaton, APHA, AWWA,WEF
11. Chemistry for Environmental Engineering and Science: C N Sawyer, P L McCarty and G F Parkin
12. Laboratory Manual for the Examination of Water, waste water and soil: H H Rupa and H Krist, V C H Publication
13. Manual on Water and Waste water analysis: D S Ramteke and C A Moghe, NEERI
14. Environmental Chemistry: B K Sharma and H Kaur
15. Environmental Chemistry: A K De
16. Environmental Pollution- Management and control for sustainable Development: R K Khatoliya
17. Environmental Chemistry: A K Bhagi and G R Chatwal

Semester III

Paper XI **(**Code**:** 3T3**)**

Elective**-** Polymer Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit**-I:**Introduction to polymers 15h

Nomenclature and classification of polymers, Polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization and their mechanisms, Types of polymers- linear, branched, crosslinked, ladder, thermoplastic, thermosetting, fibres, elastomers, natural polymers, addition and condensation polymers.Stereoregular polymers- atactic, syndiotactic and isotactic.

Unit**-II:**Molar mass and its determination 15h

Molecular mass and molar distribution. Number average, mass average, viscosity, average molecular mass and relation between them. Molecular mass distribution. Determination of molecular mass- Osmometry (membrane and vapour phase), light scattering, gel permeation chromatography, sedimentation and ultracentrifuge, viscosity method and end-group analysis.

Unit III: Physical characteristics of polymers 15h

Morphology and order in crystalline polymers. Configuration of polymer chains, crystal structure of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. The glass transition temperature (Tg), relationship between T_g and T_T, Effect of molecular weight, dilments, chemical structure, chain topology, branching and cross linking. Methods of determination of glass transition and crystallinity of polymers.

Unit IV: Commercial polymers 15h

A) Organic polymers: Commercial polymers, synthesis and and application of polyethylene, Cellulose Acetate, PMMA, polyaimdes, polyesters, Urea resins and eposy resins.

B) Functional polymers: Fire retarding polymers and conducting polymers, biomedical polymers.

Semester III

Practical VI – Elective (Code: 3P3)

Polymer Chemistry Practical

12h per week Marks-100

1. Synthesis of polymers:
   a) Synthesis of Thiokol rubber (condensation)
   b) Urea-formaldehyde (condensation)
   c) Glyptal resin: glycerine phthalic acid (crosslinked Polymer Chemistry)
   d) Polyacryonitril (bulk polymerization)
   e) Polyacryonitril (emulsion polymerization)
   f) Polymethylomethacrylate (emulsion of suspension Polymer Chemistry)
   g) Nylon-66 (interfacial polycondensation)
   h) Coordination polymers
   i) Conducting polymer (electro- or peroxodisulphate oxidation)
2. Characterization of polymers:
   a) End-group analysis
   b) Viscosity and molecular mass
   c) Density of polymer by flotation methods
   d) IR spectra.
3. Purification and fractionation of polymer, polystyrene, Nylon 66, PMMA.
4. Magnetic and electrical properties of polymers, magnetic susceptibility and electrical conductivity of coordination and conducting polymers.
5. Thermal analysis and degradation of polymers:
   i. TGA: Isothermal and non-isothermal;
   ii. DTA: Glass transition temperature and melting point
6. Crystallinity of polymers by density measurement.
7. Swelling and solubility parameters of polymers.
8. Synthesis of Graft-Polymers and its characterization by density and IR spectra.
9. Dielectric behavior of polymers.
10. Kinetics of polymerization:
    a) Polycondensation
    b) Peroxide initiation polymerization.

List of books:

1. Textbook of polymer science: F.W. Billmayer Jr. Wiley.
2. Polymer science: V.R. Gowarikar, N. V. Viswanathan and J. Sreedhar, Wiley-Eastern.

3. Fractional monomers and polymers: K Takemoto, Y. Inaki, and R.M. Ottam Brite.
4. Contemporaty polymer chemistry: H.R. Alcock and F. W. Lambe, Prentice Hall.
5. Principles of polymer Chemistry: Flory, Cornell Univ. press.
6. Introduction to polymer chemistry: R. B. Seymour, McGraw Hill.
7. Principles of polymerization: Odian.
8. A first course in polymer chemistry: A. Strepikheyew, V. Derevistkay and G. Slonimasky, Mir Publishers, Moscow.
9. Laboratory preparation of macro chemistry: EMM effery, McGraw Hill Co.
10. A practical course in polymer chemistry: S.J. Punea , Pergamon Press.

Semester III

Paper XI Elective (Code: 3T3)

Medicinal Chemistry

60 h (4 h per week): 15 h per unit — 80 Marks

UNIT-I: 15 h

Drug Design:

Development of new drugs, factors affecting development of new drugs, sources of lead compounds, serendipity and drug development. Concept of QSAR, QSAR methods and parameters, procedure followed in drug design, structure activity relationship (SAR) method, Free and Wilson analysis, Hansch analysis, concept of prodrugs and softdrugs, SOFT DRUGS, isosterism, bioisosterism, drug receptors, theories of drug action, types of reversible enzyme inhibitors, some special inhibitors and design of inhibitors.

UNIT-II:

15 h

A] Pharmacokinetics and pharmacodynamics: Indroduction drugs absorption, distribution and disposition of drugs, excretion and elimination, Pharmacokinetics of elimination and Pharmacokinetics in drug development process.
Pharmacodynamics: Introduction, enzyme stimulation, enzyme inhibition, membrane active drugs, drugs metabolism, biotransformation and significance of drug metabolism

B] Diuretics: Introduction, mode of action, loop diuretics. Synthesis of Bumetanide, Frusemide, Ethacrynic acid, clorexolone Quinethazone.

C] Analgesics and Antipyretics: Introduction, mode of action, evaluation of analgetic agents.Synthesis of: Aspirin, salsalate, phenacetin, phenylbutazone, Indomethacin, Analgin.

UNIT-III:

15h

A] Cardiovascular Drugs: Introduction, cardiovascular diseases, Synthesis and uses of cardiovascular drugs; amyl nitrate, diltiazem, varapamil, methyldopa, atenolol, sorbitrate, quinidine, oxyprenolol

B] Antineoplastic Agent: Introduction, mechanism of tumor formation, treatment of cancer, types of cancer chemotherapy, role of alkylating agents and antimetabolites in treatment of cancer, carcinolytic antibiotics, mitotic inhibitors, harmones, natural products. Synthesis of melphalan , thiotepa, lomustine

UNIT-IV:

15 h

A] Psychoactive drugs: Introduction, neurotransmitters, structure of nerve cell, chemical transmitters, CNS depressants, sedative and hypnotics, Synthesis of Barbiturates, Phenobarbital, thiopental sodium, diazepam, lorazepam, bromazepam, ethosuximide, general anaesthetic: Antianxiety drugs, synthesis of oxazepam, alprazolam, puspirone, antipsychotic drugs and antidepressant drugs, MAO inhibitors, antimanic drugs, synthesis of thiopental sodium, ethiosuxmide, glutethimide, trimethadione, phenytoin.

B] Coagulant and Anticoagulants: Introduction, factors affecting coagulant and anti-coagulant. Mechanism of Blood coagulation and Anticoagulation. Structure of Vitamin K1, Vitamin K2 and heparin. Synthesis of Coumarins and indanediones.

Semester III

Practical VI–Elective (Code: 3P3)

Medicinal Chemistry Practical

12 h per week Marks-100

1. Volumetric estimation of Ibuprofen.
1. Estimation of aspirin by volumetric and instrumental methods.
2. Analysis of ascorbic acid in biological/tablet sample.
3. Determination of paracetamol by colorimetry.
4. Analysis of ampicillin trihydrate.
5. Determination of vitamin B12 in commercial sample by spectrophotometry.
6. Determination of phenobarbitone in given cough syrup.
7. Determination of tetracycline in given capsule.
8. Determination of iron, calcium and phosphorus from milk or drug sample.
9. To perform I.P. monograph of tablet.
10. Estimation of chloride in serum and Urine.
11. Separation and determination of sulpha drugs in tablets or ointments.

Preparation of Drugs: Synthesis, purification and identification of (8-10) of the following drugs.

1. Benzocaine from p-nitrobenzoic acid.
2. Dapsone from diphenyl sulphone.
3. Paracetamol from p-nitro phenol.
4. Uracil from sulphanil amide.
5. Diphenyl hydantion from benzoin.
6. Aluminium asprin from salicylic acid.
7. 4,6-diphenyl-thiazine from chalcone.
8. 6/8 nitro coumarin from resorcinol.
9. Copper aspirin from salicylic acid.
10. N-acetyl parabanic acid.
11. Nerolin from 2-naphthol
12. Phenothiazine from diphenylamine
13. Umbelliferon from resorcinol
14. Benzylidene from benzaldehyde and aniline
15. 1-phenyl-1,2-pentadine-3-one from benzaldehyde
16. 1,5 diphenyl-1,3-pentadiene-2-one from benzaldehyde
17. 1,3-diphenyl-prop-2-ene-1-one
18. 3-methy pyrazol-5-one from ethylacetoacetate
19. 6-methyl uracil
20. Sulphanilamide from acetanilide

List of books:

1. Text book of organic medicinal chemistry-Wilson,Geswold
2. Medicinal chemistry Vil I and II-Burger
3. A textbook of pharmaceitical chemistry-Jayshree Ghosh
4. Introduction to medicinal chemistry-A Gringuadge
5. Wilson andGisvold text book of organic medicinal and pharmaceutical chemistry-Ed.Robert F Dorge
6. An introduction to drug design-S S Pandey,and JR Demmock
7. Goodman and Gilmans pharmacological basis of therapeutics- Stragies for organic drug sythesis and design-D Lednicer

8. Textbook of Medicinal Chemistry- A. Kar
9. Medicinal Chemistry – D Sriram and P. Yogeeswari

Semester III

Paper XII (Code: 3T4)

Foundation Course - IApplied Analytical Chemistry– I

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Analysis of Pesticides and Fertilizers 15h

Pesticides: General introduction, analysis of pesticides in general with reference to DDT, Dieldrin, Malathion, Parathion, BHC by different analytical methods such as titrimetric, colorimetric, chromatography and electroanalytical methods.

Fertilizers: Sampling and sample preparation, determination of water, total nitrogen, urea, total phosphates, potassium, acid or base forming quality.

Unit-II: Forensic chemistry 15h

Introduction. Classification of poisons on the basis of physical states, mode of action and chemical properties with examples of each type. Methods of administration. Action of poisons in body. Factors affecting poisoning. Study of some common poisons used for suicide. Signs and symptoms of As, Pb, Hg and cyanide poisoning. Poisonous effects of kerosene and cooking gas.

Unit-III:Analysis of petroleum and petroleum products 15h

Introduction, determination of flash and fire point, Pensky Marten's apparatus, cloud and pour point, aniline point, drop point, viscosity and viscosity index, Redwood and Saybolt viscometer, API specific gravity, water and sulphur in petroleum products, carbon residue, corrosion stability, decomposition stability, emulsification, neutralization and saponification number.

Unit-IV: Analysis of alloys 15h

Definition of alloy. phase diagrams of Fe-C, Pb-Sn, Pb-Ag systems and their applications. Types of steel: hypoeutectic, hypereutectic steels, mild steel, and stainless steel. Uses of steel. Composition and uses of brass, bronze and soldering alloy. Analysis of iron, nickel, chromium and manganese in steel. Analysis of copper and zinc in brass, lead and tin in soldering alloy. Industrial applications of alloys.

OR

Semester III

Paper XII (Code: 3T4)

Core Subject Centric - I: Spectroscopy– I

60 h (4 h per week): 15 h per unit 80 Marks

Unit - I: Symmetry properties of molecules and group theory: 15h

Symmetry elements and symmetry operations. Properties of group. Point groups and Schoenflies symbols. Symmetry operations as a group. Matrix representations of groups. Multiplication table for C_{2v}, C_{3v} and C_{2h}. Reducible and irreducible representations. Similarity transformation. Classes of symmetry operations. Great Orthogonality Theorem. Derivation of character tables for H_2O and NH_3 using Great Orthogonality Theorem. Application of character tables in selection rules of IR, Raman and Electronic spectroscopy.

Unit - II: 15h

A] Mass spectrometry: Theory, ion production(EI, CI, FD, FAB), ion analysis, ion abundance, isotopic contribution, N-rule, types of fission processes, high resolution mass spectrometry, metastable peak, molecular ion peak, Mclaffferty rearrangement, mass spectral fragmentation of organic compounds alkanes, alkenes, alkynes, alcohols, amines, amides, acids, aldehydes, ketones, halides, Structure determination of organic molecules by mass spectrometry, problem based on mass spectral data

B] Mössbauer spectroscopy: Basic principle, experimental techniques, recoil emission and absorption, source, absorber, isomer shift, quadrupole interaction, magnetic hyperfine interaction,

applications in determining electronic structure, molecular structure, crystal symmetry, magnetic structure, surface studies, biological applications.

Unit **-** III**:** 15h

A**]** Microwave spectroscopy: Classification of molecules on the basis of M.I., rigid and non rigid rotor, effect of isotopic substitution on transition frequencies, stark effect, microwave spectrometer, application in deriving: molecular structure, dipole moment, atomic mass and nuclear quadrupole moment.

B**]** ESR spectroscopy: Introduction, principle of ESR, ESR spectrometer, hyperfine coupling, zero field splitting, factors affecting g values, Kramer's degeneracy, application of ESR spectra to study free radicals like hydrogen, methyl radical, 1,4-semibenzoquinone, naphthalene, transition metal complexes, biological systems.

Unit IV**:** 15h

A**]** Infrared spectroscopy: Diatomic molecules: 1) Molecules as harmonic oscillator, Morse potential energy function, vibrational spectrum, fundamental vibrational frequencies. Force constant, zero point energy, isotope effect. The Anharmonic oscillator, the interactions of rotations and vibrations. P,Q,R branches, vibration of polyatomic molecules, selection rules, normal modes of vibration, group frequencies, overtone and combination frequencies. Structure determination of organic molecules by IR spectroscopy, problem based on IR spectral data

B**]** Raman Spectroscopy: Rayleigh scattering. Raman Scattering, classical and quantum theories of Raman effect. Rotational Raman Spectra for linear and symmetric top molecules. Vibrational Raman Spectra, rotational fine structure. Selection rules, coherent antiStokes Raman spectroscopy, Structure determination from Raman and Infra-red spectroscopy.

List of books

1] Spectroscopic identification of organic compound-RM Silverstein,GC Bassler and TC Morril, John Wally
2] Introduction to NMR spectroscopy-R. J. Abraham, J. Fisher and P Loftus Wiely
3] Application of Spectroscopy to Organic Compound-J. R. Dyer, Printice Hall
4] Organic Spectroscopy-William Kemp, ELBS with McMillan
5] Spectroscopy of Organic Molecule-PS Kalsi, Wiley, Esterna, New Delhi
6] Organic Spectroscopy-RT Morrison and RN Boyd
7] Practical NMR Spectroscopy-ML Martin, JJ Delpench, and DJ Martyin
8] Spectroscopic Methods in Organic Chemistry-DH Willson, I Fleming
9] Fundamentals of Molecular Spectroscopy-CN Banwell
10] Spectroscopy in Organic Chemistry-CNR Rao and JR Ferraro
11] Photoelectron Spectroscopy-Baber and Betteridge
12] Electron Spin Resonance Spectroscopy-J Wertz and JR Bolten
13] NMR –Basic Principle and Application-H Guntur
14] Interpretation of NMR spectra-Roy H Bible
15] Interpretation of IR spectra-NB Coulthop
16] Electron Spin Resonance Theory and Applications-W gordy
17] Mass Spectrometry Organic Chemical Applications, JH Banyon

Semester III

Seminar**-**III **(**Code**:** 3S1**)**

2 h /week Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 25 marks (1 Credit). Seminar should be delivered by the student under the guidance of concerned teacher on the topic allotted by the teacher. The topic will be related to the syllabus. Marks will be allotted by a group of teachers.

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M.Sc. Chemistry Semester IV
INORGANIC CHEMISTRY SPECIALIZATION
Paper XIII(Code: 4T1)
Special I-Inorganic Chemistry

60h (4h/week) 15h/ unit 80 Marks

Unit-I 15h

A) Nanoparticals & Nanostructural materials :Introduction, methods of preparation, physical properties, and chemical properties. Molecular Precursor routes to inorganic solids:- Introduction, sol-gel chemistry of metal alkoxide, hybrid organic-inorganic compounds. Nanoporous Materials: Introduction, Zeolites & molecular sieves, determination of surface acidity, porous lamellar solids, composition-structure, preparation & applications.

B) Solid State Reaction: General principles, reaction rates, reaction mechanism, reaction of solids, factors influencing reactivity, photographic process.

Unit-II 15h

A) Coordination Polymers:Coordination polymers and their classification. Synthesis and applications of coordination polymers. Use of polymeric ligands in synthesis of coordination polymers. Organosilicon polymers. Synthesis and their uses.

B) Characterization of coordination polymers on the basis of:
i) Spectra (UV, Visible, IR and NMR)
ii) Magnetic and thermal (TGA,DTA and DSC) studies

Unit-III 15h

Catalysis: Basic principles, thermodynamic and kinetic aspects, industrial requirements, classification, theories of catalysis, homogeneous and heterogeneous catalysis .Introduction, types & characteristics of substrate-catalyst interactions, kinetics and energetic aspects of catalysis, selectivity, stereochemistry, orbital symmetry and reactivity. Catalytic reactions of coordination and Organometallic compounds including polymerization activation of small molecules, addition to multiple bonds, hydrogenation Zeigler-Natta polymerization of olefins, hydroformylations, oxidations, carbonylations and epoxidation.

Name organic reaction involving inorganic compounds: Suzuki Coupling, Heck Reaction, Negishi reaction and Sonogirhra reaction

Unit-IV 15h

A) Optical sensor for metal Ions: Chelates ligand (Multidentates, Ruthenium bipyridyls, calixarenes, Lanthanide ion); Macrocyclic ligands (Flexible Macrocycles, Azamacrocycles, Cryptands, porphyrins); Crown ether and Cryptands(Napthalene and Anthracene crowns, Cryptands, structural features)

B) Thin films and languir-Biodgett films: Preparation technique, evaporation/spultering, chemical processe MOCVD, solgel etc. Languir-Biodgett(LB) film, growth techniques, photolithography properties and applications of thin and LB films.

List of books:

1. Barsoum ,M.W.,Fundamentals of Ceramics,McGraw Hill ,New Delhi
2. Ashcroft ,N.W. and Mermin,N.D.,SolidStaePhysics,Saunders College
3. CallisterW.D.,Material Science and Engineering, An Introduction,Wiley
4. Keer,H.H,Principals of Solid State,Wiley Eastern
5. Anderson J.C.,LeverK.D.,Alexander J.M and Rawlings,R.D.,ELBS
6. GrayG.W.Ed.Thermotropic Liquid Crystals,John Wiley
7. Kelkar and Hatz Handbook of Liquid Crystals,ChemieVerlag.
8. Kalbunde K.I.,Nanoscale Materials in Chemistry,JohnWiley,NY.
9. Shull R.D.,McMichael R.D. and SwartzendrubL.J.,Studies of Magnetic Properties of Fine particles and their relevance to Mataerials Science, Elsevier Pub. Amsterdam

10. Optoelectronic Properties of Inorganic Compounds, D. Max Roundhill and John P. Fakler, Jr. Plenum Press, New York

Semester IV

Paper XIV(Code: 4T2)

Special II-Inorganic Chemistry

60h (4h/week) 15h/ unit 80 Marks

Unit-I 15 h

A) Basics of Photochemistry: Absorption, excitation, photochemical laws, quantum yield, electronically excited states-life times-measurements of the times. Flash photolysis, stopped flow techniques, Energy dissipation by radiative and no-radiative processes, absorption spectra Frank-Condon principles; photochemical stages-primary & secondary processes.

B) Properties of excited states: Photochemical kinetics,Calculation of rates of radiative processes.

C) Excited States of Metal Complexes: Electronically excited states of metal complexes, charge transfer spectra, charge transfer excitations, metods for obtaining charge transfer spectra.

Unit-II 15h

A] Photophysical and photochemical properties of Gold(I) complexes: Introduction, Binuclear and trinuclear complexes, Mixed metal Systems, Photochemical reactivity, Solid state studies, Mononuclear Gold(I) complexes, Mononuclear three coordinate Gold(I) complexess

B) Redox reactions by Excited Metal Complexes: Energy transfer under conditions of weak interaction & strong interaction – exciplex formation, conditions of excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2-bipyridine & 1,10-Phenanthroline complexes.), illustration of reducing and oxidizing character of ruthenium (II); role of spin-orbit coupling, lie time of these processes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants in to highenergy products, chemical energy in to light.

Unit-III 15h

Organotransition Metal Chemistry: Alkyls and Aryls of Transition Metals: Types, routes of synthesis, stability &decomposition pathways of alkyls & aryls of transition metals. Organocopper in Organic synthesis. Compounds of Transition Metal –Carbon Multiple bonds: Alkylidenes, alkylidynes, low valent carbenes & carbynes–synthesis, nature of bond, structural characteristics, nucleophilic & electrophilic reactions on ligands, role inorganic synthesis.

Unit-IV 15h

Transition Metal Pi Complexes-Carbon multiple bonds. Nature of bonding, structural characteristics & synthesis, properties of transition metal pi- Complexes with unsaturated organic molecules, alkenes alkynes, allyl, diene, dienyl, arene & trienyl complexes. Application of transition metal, organometallic intermediates in oraganic synthesis relating to nucleophilic & electrophilic attack on ligands, role in organic synthesis.

List of books:

1. ElschenbroichCh.andSalzer A.: Organometallics, VCH,Weinheim, NY.
2. BalzaniVandCavassitiV.:Photochemistry of Coordination compounds,AP,London
3. Purcell K.F.andKotzJ.C., An Introduction to Inorganic Chemistry,HoltSounder,Japan.
4. RohtagiK.K.andMukharjee,Fundamentals of Photochemistry,Wiley eastern
5. CalvertsJ.G.and Pits.J.N., Fundamental of Photochemistry, John Wiley
6. Wells, Inorganic Solid State Chemistry, Oxford University, Vth , Edition
7. Paulson,OrganometallicChemistry,Arnold
8. Rochow,OrganometallicChemistry,Reinhold
9. Zeiss,OrganometallicChemistry,Reinhold
10. Gilbert A.andBaggott,J,Essential of Molecular Photochemistry,BlackwellSci.Pub.
11. TurroN.J.and Benjamin W.A.,Molecular Photochemistry

12. CoxAandCamp,T.P.IntroductoryPhotochemistry,McGraw-Hill
13. KundallR.P.andGilbertA,Photochemistry, Thomson Nelson Coxon J and HaltonB.,Organic Photochemistry, Cambridge University Press.
14. Optoelectronic Properties of Inorganic Compounds, D. Max Roundhill and John P. Fakler, Jr. Plenum Press, New York

Semester IV

Practical-VII (Code: 4P1)

Inorganic Chemistry SpecialPractical

12 h /week Marks: 100

A Preparation and characterization of following complexes/organometallic compound including their structural elucidation by the available physical methods.(element analysis molecular weight determination, conductance and magnetic measurement and special studies)

1 Preparation of mercury tetrathiocyanotocobaltate(II)
2 Preparation of Iron (II) oxalate & potassium trioxalatoferrate (III) trihydrate
3 Preparation of cis & trans potassium dioxalatodiaquochromate (III)
4 Preparation of hexa-aminecobalt(III) chloride
5 Preparation of hexa-aminenickel(II) chloride
6 Preparation of tris (acetylacetonato) manganese (III)
7 Preparation of N-N bis (salicyldehyde) ethylene diaminonato nickel (II)
8 Preparation of trinitrotriaminocobalt(III)
9 Preparation of chloropentammine cobalt (III) chloride
10 Preparation of potassium trioxalatochromate (III)
11 To prepare copper (II) acetylacetonate complex
12 To prepare cis and trans bis (glycinato) Cu II monohydrate complex
13 To prepare dipyridineiodine (I) nitrate
14 Preparation of ammonium nickel(II) sulphate

B SOLID STATE

1 Preparation of oxides and mixed oxides(MnO_2 , NiO, Cu_2O,Fe_3O_4,$ZnFe_2O_4$,$ZnMn_2O_4$,$CuMnO_4$and $NiFe_2O$)
2 Preparation of silica and alumina by sol –gel technique
3 To study the electrical conductivity of ferrites, magnetite's, doped oxides and pure samples and determine band gap

C SEPARTION AND QUANTITATIVE ESTIMATION OF BINARY AND TERNARY MIXTURE BY THE USE OF FOLLOWING TECHNIQUES:

1 Paper and thin layer chromatography
2 Ion exchange
3 Solvent extraction

D INORGANIC PHOTOCHEMISTRY

1. Synthesis of potassium ferrioxalate and determination of intensity of radiation
2. Photo oxidation of oxalic acid by UO^{2+}sensitization
3. Photo decomposition of HI and determination of its quantum yield

List of books:

1. Practical Inorganic Chemistry - Pass
2. Practical Inorganic Chemistry - Marr & Rocket
3. Basic Concept Of Analytical Chemistry - Khopkar S. M.
4. Synthesis And Characterisation Of Inorganic Compounds – W. L. Jolly, Prentice Hall
5. Inorganic Experiments – J. Derck Woollins, Vch.
6. Practical Inorganic Chemistry – G. Marrand, B.W. Rockett, Van Nostrand
7. A Text Book Of Quantitative Inorganic Analysis – A.I. Vogel, Longoman.
8. Edta Titration – F. Laschka

9. Instrumental Methods Of Analysis – Willard, Merit And Dean (Cbs, Delhi)
10. Inorganic Synthesis – Jolly
11. Instrumental Methods Of Chemical Analysis – Yelri Lalikov
12. Fundamental Of Analytical Chemistry- Skoog D .A. And West D. M. Holt Rinehart And Winston Inc.
13. Experimental Inorganic Chemistry7 – W.G. Palmer, Cambridge
14. Solid Stst Chemistry – N.B. Hanney
15. Introduction To Thermal Analysis , Techniques And Applications – M. E. Brown, Springer
16. Preparation And Properties Of Solid State Materials – Wilcox, Vol I&Ii, Dekker
17. The Structure And Properties Of Materials – Vol Iv, John Wulff,Wiley Eastern

Semester IV

ORGANIC CHEMISTRY SPECIALIZATION

Paper XIII (Code: 4T1)

Special I-Organic Chemistry

60h (4h/week) 15h/ unit 80 Marks

Unit I:

A] Carbanions in organic Chemistry 15 h

Ionization of carbon hydrogen bond and prototopy, Base and acid catalysed halogenation of ketones, keto-enol equilibria, structure and rate in enolisation, concerted and carbanion mechanism for tautomerism, geometry of carbanions, kinetic and thermodynamic control in the generation of enolates, LDA, hydrolysis of haloforms, use of malonic and acetoacetic esters, Aldol, Mannich, Cannizzaro, Darzens, Dieckmann, Claisen Baylis-Hillman reactions, Knoevenagel, benzoin condensation, Julia olefination, alkylation of enolates and stereochemistry thereof, Conjugate additions, enamines in organic synthesis

B] Organometallic reagents -I

Synthesis and applications of organo Li and Mg reagents, nucleophilic addition to aldehyde, ketones, ester, epoxide, CO_2, CS_2, isocyanates, ketenes, imines, amides, lactones, Stereochemistry of Grignard addition to carbonyl compounds, *o*-metallation of arenes using organolithium compounds.

Unit II: 15 h

A] Organometallic reagents-II:Organozinc reagents: Preparation and applications, Reformatsky reaction, Simon-Smith reaction.

Organocopper reagents: Preparation and applications in C-C bond forming reaction, mixed oragnocuprates, Gilman's reagent. Organo Hg and Cd reagents in organic synthesis.

B] Transition metals in organic synthesis: Transition metal complexes in organic synthesis-Introduction-oxidation states of transition metals, 16-18 rule, dissociation, association, insertion, oxidative addition, reductive elimination of transition metal

Organopalladium in organic synthesis-Heck reaction, carbonylation, Wacker oxidation, coupling reactions: Kumada Reaction, Stille coupling, Sonogashira, Negishi and Suzuki coupling reactions and their importance

Applications of $Co_2(CO)_8$, $Ni(CO)_4$, $Fe(CO)_5$ in organic synthesis. Wilkinson catalyst of Ruthenium and Rhodium – synthesis and uses its use in hydrogenation reactions-deallylation, C-C, C-O, C-N bond cleavages. Olefin metathesis by I^{st} and II^{nd} generation catalyst, reaction mechanism and application in the synthesis of homo and heterocyclic compounds

Unit III: 15 h

A] Advanced Stereochemistry: Conformation of sugars,monosaccharides, disaccharides, mutorotation, Recapitulation of Stereochemical concepts- enantiomers, diastereomers, homotopic and heterotopic ligands, Chemo-, regio-, diastereo- and enantio-controlled approaches; Chirality transfer, Stereoselective addition of nucleophiles to carbonyl group: Re-Si face concepts, Cram's rule, Felkin Anh rule, Houk model, Cram's chelate model. Asymmetric synthesis use of chiral auxiliaries, asymmetric hydrogenation, asymmetric epoxidation and asymmetric dihydroxylation,

B] Protection and Deprotection of functional groups: Protection and deprotection of functional groups like, hydroxyl, amino, carbonyl and carboxylic acids groups, Solid phase peptide synthesis.

Unit IV: Designing the synthesis based on retrosynthetic analysis 15 h

A) Disconnection Approach: An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis

B) One Group C-C Disconnections: Alcohols andcarbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis

C) Two Group C-C Disconnections: Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds, Michael addition and Robinson annelation, Methods of ring synthesis, Linear and convergent synthesis

List of books

1] Principle of Organic Synthesis R. O. C. Norman and J. M. Coxon
2] Modern Synthetic Reaction. H. O. House and W. A. Benjamin
3] Organic Synthesis: The Disconnection Approach-S. Warren
4] Designing Organic Synthesis-S. Warren
5] Some Modern Methods of Organic Synthesis-W. Carruthers
6] Advance Organic Reaction. Mechanism and Structure-Jerry March
7] Advance Organic Chemistry Part-B-F. A. Caray and R. J. Sundberg Plenum Press
8] Organic Reaction and their Mechanism-P. S. Kalsi
9] Protective Groups in Organic Synthesis-T. W. Greene
10] The Chemistry of Organo Phosphorous-A. J. Kirbi and S. G. Warren
11] Organo Silicon Compound-C. Eabon
12] Organic Synthesis via Boranes-H. C. Brown
13] Organo Borane Chemistry-T. P. Onak
14] Organic Chemistry of Boron-W. Gerrard

Semester IV

Paper XIV(Code: 4T2)

Special II-Organic Chemistry

60h (4h/week) 15h/ unit 80 Marks

Unit I: Enzyme chemistry 15h

A] Enzymes: Introduction, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Nomenclature and classification, Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Baker's yeast catalyzed reactions

B] Mechanism of Enzyme Action: Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

C] Co-Enzyme Chemistry: Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, lipoic acid, biotin as CO_2 carrier. Mechanisms of reactions catalyzed by the above cofactors.

Unit II: Heterocycles 15h

A*]* Azoles**:** Structural and chemical properties; Synthesis of pyrazole, isothiazole and isoxazole; Synthesis of imidazoles, thiazoles and oxazoles; Nucleophilic and electrophilic substitutions; Ring cleavages, Carbonyldiimidazole as coupling agent

B*]* Benzofused heterocycles**:** Synthesis of indole, benzofuran and benzo-thiophene, quinoline and isoquinoline Nucleophilic, electrophilic and radical substitutions; Addition reactions; Indole rings in biology.

C*]* Diazines**:** Structural and chemical properties; Synthesis of pyridazines, pyrimidines, pyrazines; Nucleophilic and electrophilic substitutions.

D**]** Synthesis of following bioactive compounds**:** Vitamin B_6, Ondansetron, Serotonin, Indometacin, Cyanamid, fentiazac, trimethoprim, papaverine

Unit III**:** 15h

A*]* Nucleic Acids**:** Primary, secondary and tertiary structure of DNA; DNA replication and heredity; Structure and function of mRNA, tRNA and rRNA. Purines and pyrimidine bases of nucleic acids and their preparation.

B**]** Lipids**:** Fatty acids, essential fatty acids, structures and functions of triglycerols, glycerophospho lipids, spingolipids, lipoproteins, composition and function, role in atherosclerosis
Properties of lipid aggregates, micells, bilayers, liposomes and their biological functions, biological membranes, fluid mosaic model of membrane structure, Lipid metabolism, β-Oxidation of fatty acids

C**]** Vitamins**:** Structure determination, and synthesis of vitamin A, E and H.

Unit IV**:** 15h

A**]** Dyes**:** General Introduction, classification on the basis of structure and methos of application dying mechanism, methods of dying, such as direct dying, vat dying, dispersive dying, formation of dye in fibre, dying with reactive dyes, study of quinoline yellow, cyamine dye, ethyl red, methylene blue, Alizarin, cyamine-green, fluorescein, cosin, erythrosine, Rhodomines and Indigo.

B**]** Pharmaceutical chemistry**:**
History, medical terms in pharmaceutical chemistry, classification of drugs, antibacterial and antifungal drugs, specific clinical applications, Synthesis and applications of: Benzocaine, Methyl dopa, dilantin, ciprofloxacin, acyclovir, terfenadine, salbutamol

C**]** Polymer chemistry**:** Importance of polymers, Basic concepts: monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization and their mechanisms, Polymerization in homogeneous and heterogeneous systems. Ziegler-Natta polymerization with mechanism, Stereo regulated polymers, syndiotactic, isotactic and atactic polymers

List of books

1] Textbook of Polymer Science, F. W. Billmeyer Jr, Wiley
2] Polymer Science, V. R. Gowarikar, N. V. Viswanathan and J. Sreedhar, Wiley-Eastern
3] Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R. M. Ottanbrite
4] Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag
5] Understanding Enzymes, Trevor Palmer, Prentice Hall
6] Enzyme Chemistry: Impact and Applications, Ed. Collin J. Suckling, Chapman and Hall
7] Enzyme Structure and Mechanism, A. Fersht, W. H. Freeman
8] Introduction to Medicinal Chemistry, A. Gringuage, Wiley-VCH
9] Wilson and Gisvold's Text Book of Organic Medical and Pharmaceutical Chemistry, Ed Robert F. Dorge
10] Burger's Medicinal Chemistry and Drug Discovery, Vol-1, Ed. M. E. Wolff, John Wiley
11] Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley
12] The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press

Semester IV
Practical-VII (Code: 4P1)
Organic Chemistry Special Practical

12 h /week Marks: 100

A] Quantitative Analysis based on classical and instrumental technique (any 9-10)

1] Estimation of nitrogen.
2] Estimation of halogen.
3] Estimation of sulphur.

Spectrophotometric/calorimetric and other instrumental methods of estimation

1] Estimation of streptomycin sulphate.
2] Estimation of vitamin B-12.
3] Estimation of amino acids.
4] Estimation of proteins.
5] Estimation of carbohydrates.
6] Estimation of Ascorbic acid.
7] Estimation of Aspirin.
8] Solvent extraction of oil from oil seeds and determination of saponification value, iodine value of the same oil.

B] Organic multi-step preparations (Two/Three steps): Minimum 10-12 preparations

[1] Aniline → Diaminoazobenzene → p-aminoazobenzene
[2] Benzoin → Benzyl → Dibenzyl
[3] Aniline → acetanilide →*p*-bromoacetanilide →*p*-bromoaniline
[4] Aniline → Acetanilide →*p*-nitroacetanilide →*p*-nitroaniline
[5] Benzaldehyde (thiamine hydrochloride) → benzoin → benzil → benzilic acid
[6] *p*-Nitrotoluene →*p*-nitrobenzoic acid→ PABA →*p*-iodobenzoic acid
[7] *p*-Cresol →*p*-cresylacetate → 2-hydroxy-5-methyl acetophenone → 2-hydroxy chalcone
[8] Benzaldehyde → benzilidene acetophenone → 4,5-dihydro-1,3,5-triphenyl-1*H*-pyrazole
[9] Aniline → phenylthiocarbamide → 2-aminobenzthiazole (Microwave in step I)
[10] Chlorobenzene → 2,4- Dinitrochlorobenzene → 2,4- Dinitrophenylhydrazine.
[11] Acetophenone → acetophenone phenyl hydrazone → 2-phenylindole
[12] Benzion → benzoin benzoate → 2,4,5-triphenyl oxazole
[13] Benzophenone → benzpinacol → benzopinacolone (Photochemical preparation)
[14] Benzophenone → Benzophenone oxime → Benzanilide → Benzoic acid + aniline
[15] Aniline → aniline hydrogen sulphate → sulphanilic acid → Orange II
[16] Aniline → N-arylglycine → indoxyl → indigo
[17] Phthalimide → Anthranilic acid → Phenyl glycine-o-carboxylic acid → Indigo
[18] Phalic anhydride → Phthalimide → Anthranilic acid → o-chlorobenzoic acid
[19] Phalic anhydride → Phthalimide → Anthranilic acid →Diphenic acid
[20] Ethyl acetoacetate → 3-methyl-pyrazol-5-one → 4,4-dibromo-3-methyl-pyrazol-5-one Butanoic acid
[21] Biosynthesis of ethanol from sucrose
[22] Enzyme catalyzed reactions

[C] SPECTRAL INTERPRETATION

Structure Elucidation of organic compounds on the basis of spectral data (UV, IR, ^{1}H and ^{13}CNMR and Mass) (Minimum 12 compounds are to be analysed during regular practicals).

Semester IV
PHYSICAL CHEMISTRY SPECIALIZATION

Paper XIII(Code: 4T1)
Special I-Physical Chemistry)

60h (4h/week) 15h/unit 80 Marks

UNIT-I CHEMICAL DYNAMICS - II 15h

A] Overview of Arrhenius rate law, Non-conventional equilibrium between reactants and activated complexes. Potential energy surfaces and reaction coordinate. Derivation of transition state theory based equation for rate constant of bimolecular reaction. Prediction of rate constant using partition function and comparison with that given by collision theory. Arrhenius equation and activated complex theory. Transmission coefficient, quantum mechanical tunneling,

B] Reactions in solution: Cage effect, diffusion controlled reactions, volume of activation its determination and correspondence with entropy of activation, Ionic reactions: Primary (Ionic strength) and Secondary salt effect and their nature.

UNIT II CORROSION AND CORROSION ANALYSIS 15h

A] Scope and economics of corrosion, causes (Change in Gibbs free energy), Electrochemical Series and Galvanic series, dry (atmospheric) and wet (electrochemical) corrosion, other types of corrosion- Pit, Soil, chemical and electrochemical, inter-granular, waterline, microbial corrosion, measurement of corrosion by different methods, factors affecting corrosion, passivity, galvanic series, protection against corrosion, design and material selection.

B] Thermodynamics of corrosion, corrosion measurements (Weight loss, OCP measurements, polarization methods), passivity and its breakdown, corrosion prevention (electrochemical inhibitor and coating methods).

UNIT – III: RADIATION CHEMISTRY 15h

A] Interaction of radiation with matter, radiation track spurs and □-rays. Linear energy transfer, Bathe's equation for linear energy transfer, Bresstrahlung effect, Passage of neutron through matter, Interaction of □-radiation with matter, photoelectric effect and Compton effect, pair production phenomena, units of measuring radiation absorption, Radiolysis of water, Radiolysis of some aqueous solutions. Effect of radiation on biological substances, genetic effects, Radiation effects on organic compounds and Polymers.

UNIT IV: ELECTRICAL AND THERMAL PROPERTIES OF SOLIDS 15h

A] Classical free electron theory, electrical conductivity, thermal conductivity, Wiedemann-Franz Law, Lorenz number, Electronic distribution in solids using Fermi Dirac Statistics, The Fermi Distribution function and effect of temperature, Quantum theory of free electrons, periodic potential, The Kronig-Penney Model, Brillouin Zones, Distinction between metals, insulators and intrinsic semiconductors based on above theory.

B] Thermal Properties: Specific heat of solids, Classical theory, Einstein's theory of heat capacities, Debye theory of heat capacities or Debye T-cubed law

Books Sugggested:

1. G.M.Panchenkov and V.P.Labadev, " Chemical Kinetics and catalysis", MIR Publishing
2. E.A. Moelwyn- Hughes, " Chemical Kinetics and Kinetics of Solutions", Academic
3. K.J.Laidler, Chemical Kinetics, Third Edition (1987), Harper and Row, New York
4. J.Raja Ram and J.C.Kuriacose, Kinetics and Mechanism of Chemical Transformations MacMilllan IndianLtd., New Delhi (1993)
5. C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, Vol 1., Elsevier Publications, New York, 1969.
6. C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, Vol 2., Elsevier Publications, New York, 1969.

7. S. Glasstone, K. J. Laidler and H. Eyring, The Theory of Rate Processes, Mc-Graw Hill, New York, 1941.
8. Santosh Kumar Upadhyay, Chemical Kinetics and Reaction Dynamics, Springer 2006.
9. D. Mcquarie and J. Simon, Physical Chemistry – A Molecular Approach, University Press, 2000
10. G. M. Barrow, Physical Chemistry, Tata Mc-Graw Hill, V edition 2003.
11. H. K. Moudgil, Text Book of Physical Chemistry, Pretice Hall of India, New Delhi, 2010.
12. S. O. Pillai, Solid State Physics, New Age International, New Delhi, 2102.
13. C.Kittel, " Introduction to solid state Physics",Wiley
14. L.V.Azaroff, " Introduction to solids", McGraw Hill
15. Santosh Kumar Upadhyay, Chemical Kinetics and Reaction Dynamics, Springer 2006.
16. N. B. Hanny, Treaties in Solid State Chemistry, 4th Edn,
17. N. B. Hanny, "Solid State Chemistry"
18. M. C. Day and J Selbin, Theoretical Inorganic Chemistry, Reinhold Pub. Corp., New York,
19. C.N.Rao. Nuclear Chemistry
20. B. G. Harvey, *Introduction to Nuclear Physics and Chemistry,* Prentice Hall, Inc. (1969).
21. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition (1995), Wiely-Eastern Ltd., New Delhi.
22. W. Loveland, D. Morrissey and G. Seaborg, Modern Nuclear Chemistry, Wiley-Interscience, 2006.
23. P. P. Milella, Fatigue and Corrosion in Metals, Springer, 2013.
24. Corrosion- Understanding the Basics, asminternational.org, 2000.
25. H. H. Uhlig, Corrosion and Corrsion Control – 3rd edn, John Wiley & sons, New York.
26. J. W. T. Spinks and R. J. Woods, An Introduction to Radiation Chemistry, John Wiley and sons., New Yoek, 1975.
27. K. L. Kapoor, Text Book of Physical Chemistry, Vol – I to Vol-VI, 2011.

Semester IV

Paper XIV (Code: 4T2)

Special II-Physical Chemistry

60h *(4h/week)* 15h/unit 80 Marks

UNIT I: SOLID STATE AND THEIR MAGNETIC PROPERTIES 15h

A] Solid State Chemistry: Metals, Insulators and Semiconductors, Electronic structure of solids—band theory. Band structure of metals, Insulators and Semiconductors, Intrinsic and Extrinsic Semiconductors, p-n junction, energy band formation, forward bias and reversed bias p-n junction, their applications, Superconductors— types, Meissner effect, BCS theory, Low Temperature Superconductor (LTSC) and High Temperature Superconductor (HTSC), Conventional and organic Superconductors, their applications.

B] Magnetic Properties: Behaviour of substances in magnetic field, effect of temperature, Curie and Curie-weiss law, calculation of magnetic moments, magnetic materials, their structure and properties, Applications, structure/ property relations, numericals.

UNIT II: ELECTRICAL PROPERTIES OF MOLECULES 15h

Dipole moments of molecules, basic ideas of electrostatic interactions, polarizability, orientation polarization, Debye equations, limitation of the Debye theory, Clausius-Mossotti equation. electrostatic of dielectric medium, molecular basis of dielectric behavior, structural information from dipole moment measurements, use of individual bond dipole moments, application to disubstituted benzene derivatives, dipole moment and ionic character of a molecule, determination of dipole moment from dielectric measurements in pure liquids and in solutions. The energies due to dipole-dipole, dipole induced dipole and induced dipole-induced dipole interaction. Dispersion, dielectric loss and refractive index. Lennard-Jones potential.

Unit III: LIQUID STATE AND INTERFACES 15h

A] Theory of liquids: - Theory of liquids, partition function method or model approach, single cell models, communal energy and entropy, significant structure model.

B] Liquid gas and liquid interfaces: Surface tension, methods of determination of surface tension, surface tension across curved surfaces, vapor pressure of droplet (Kelvin equation), surface spreading, spreading coefficient, cohesion and adhesion energy, contact angle, constant angle hystereis, wetting and detergency.

Unit IV: IONIC LIQUIDS AND BATTERY TECHNOLOGY 15h

A] Supercooled and ionic liquids: Supercooled and ionic liquids, theories of transport properties, non Arrhenius behavior of transport properties, Cohen-Turnbull free volume model, configurational entropy model, Macedo- litovitz model, glass transition in supercooled liquids.

B] Battery Technology: basic concept, classification of batteries, primary, secondary and reserve batteries, Construction, working and application of Acid Storage batteries, Lithium - MnO_2 batteries, Nickel- Metal hydride batteries, Fuel Cells, Construction and working of $H_2O_2$and methanol-O_2 Cell.

List of books

1. S. O. Pillai, Solid State Physics, New Age International, New Delhi, 2102.
2. D. Mcquarie and J. Simon, Physical Chemistry – A Molecular Approach, University Press, 2000
3. G. M. Barrow, Physical Chemistry, Tata Mc-Graw Hill, V edition 2003.
4. H. K. Moudgil, Text Book of Physical Chemistry, Pretice Hall of India, New Delhi, 2010.
5. M. C. Day and J Selbin, Theoretical Inorganic Chemistry, Reinhold Pub. Corp., New York,
6. A. Kokorin, Ionic Liquids: Theory, Properties and New Approaches, Intech, Croatia, 2011.
7. Gholam-Abbas Nazri, Gianfranco Pistoia, Lithum Batteries-Science and Technology, Springer, 2003.
8. N. H. March and M. P. Tosi, Introduction to Liquid State Physics, World Scientific, London, 2002.
9. George Kackson, Liquid State Theory,
10. C.Kittel, " Introduction to solid state Physics",Wiley
11. L.V.Azaroff, " Introduction to solids", McGraw Hill
12. Santosh Kumar Upadhyay, Chemical Kinetics and Reaction Dynamics, Springer 2006.
13. N. B. Hanny, Treaties in Solid State Chemistry, 4th Edn,
14. N. B. Hanny, Solids,
15. H. Y. Erbil, Surface Chemistry of Solid and Liquid Interfaces, Blackwell Publishing, 2013.
16. N. B. Hanny, "Solid State Chemistry"

Semester IV

Practical-VII (Code: 4P1)

Physical Chemistry Special Practical

12 h /week Marks: 100

Adsorption:

1. To verify Freundlich adsorption isotherm.
2. To verify Langmuir adsorption isotherm.
3. To verify Gibbs adsorption isotherm and to find surface excess concentration of solute.
4. Study of variation of surface tension of solution of n-propyl alcohol with concentration and hence determine the limiting cross section area of alcohol molecule.

Kinetics:

5. Clock reaction- activation energy of bromide-bromate reaction.
6. Temp dependence of persulfate-iodide reaction by iodine clock method and calculation of thermodynamic and Arrhenius activation parameters. Study of ionic strength effect on persulfate-iodide reaction.
7. Kinetics of B-Z reaction; Kinetics of modified B-Z reaction
8. Investigate the Autocatalytic reaction between potassium permanganate and oxalic acid.
9. Determination of pKa value of a weak acid by chemical kinetic method (formate-iodine reaction)

Potentiometry:

10. Transport number by potentiometry.

11. To determine degree of hydrolysis of aniline hydrochloride and hence to determine the hydrolysis constant of salt by potentiometry method.
12. To determine pK of weak acids, succinic acid, acetic acid, Malonic acids, (dibasic acids).
13. Complexation between Hg^{2+} and I^- conductometrically.

Conductometry:

14. To determine degree of hydrolysis of aniline hydrochloride and hence to determine the hydrolysis constant of salt by conductometric method.
15. To determine pK of weak acids, succinic acid, acetic acid, Malonic acids, (dibasic acids).
16. Complexation between Hg^{2+} and I^- conductometrically.
17. To determine solubility product of lead chromate.
18. Kinetic study of saponification ethyl acetate by conductometry.

Spectrophotometry:

19. To determine the stability constant of reaction between Ferric ion solution and SCN^- ion solution by Job's method.
20. To determine the stability constant between Fe^{3+} and SCN^- ion solution by Ostwald & Frank method.

Transport Number:

21. To determine transport number by Hittorff's method
22. To determine the transport number by moving boundary method

List of Books

1. Vogel A, 3rd Edition : A Textbook Of Quantitative Inorganic Analysis, Longman
2. Das and Behra, Practical Physical Chemistry
3. Carl W. Garland, Joseph W. Nibler and David P. Shoemaker, Experiments in Physical Chemistry, Mc-Graw Hill, 8th Edition, 2009.
4. Farrington Daniels, Joseph Howard Mathews, John Warren Williams, Paul Bender, Robert A. Alberty, Experimental Physical Chemistry, Mc-Graw Hill, Fifth Edition, 1956.
5. John W. Shriver and Michael George, Experimental Physical Chemistry, Lab Manual and Data Analysis, The University of Alabama in Huntsville, Fall 2006
6. Day And Underwood :Quantitative Analysis
7. Merits And Thomas:Advanced Analytical Chemistry
8. Ewing, G. W. : Instrumental Methods Of Chemical Analysis, Mcgraw-Hill
9. Drago, R.S:Physical Methoods In Inorganic Chemistry
10. Christain G.D:Analytical Chemistry
11. Khopkar S.M.:Basic Concept Of Analytical Chemistry
12. Koltath And Ligane:Polorography
13. Braun:Instrumental Methods Of Chemical Analysis
14. Willard, Merritt And Dean: Instrumental Methods Of Chemical Analysis ,Van Nostrand
15. Strouts,Crifi;Llan And Wisin: Analytiacl Chemistry
16. Skoog S.A. And West D. W.:Fundamental Of Analytical Chemistry
17. Dilts R.V.: Analytiacl Chemistry
18. Jahgirdar D.V :Experiments In Chemistry
19. Chondhekar T.K: Systematic Experiments In Physical Chemistry, Rajbog S.W., Aniali Pubn.
20. Wlehov G. J: Standard Methods Of Chemicalanalysis 6th Ed
21. Ramesh Rand Anbu M, Chemical Methods For Envirnmental Analysis : Watewr And Sedient , Macmillion India

Semester IV

ANALYTICAL CHEMISTRY SPECIALIZATION

Paper XIII(Code: 4T1)

Special I-Analytical Chemistry

60h (4h/week) 15h/unit 80 Marks

Unit-I: Radioanalytical Chemistry-II 15h

Preparation of some commonly used radioisotopes (^{22}Na, ^{60}Co, ^{131}I, ^{65}Zn, ^{32}P), Use of radioactive isotopes in analytical and physico-chemical problems, Industrial applications, Neutron sources, Neutron Activation Analysis, Isotope Dilution Analysis, Radiometric titrations (Principle, Instrumentation, applications, merits and demerits), Radiochromatography, Carbon dating, Numericals based on above.

Unit-II: Optical methods of analysis-IV 15h

Inductively coupled plasma-atomic emission spectroscopy: Principle, atomization and excitation. Plasma source and sample introduction. Instrumentation. Comparison of ICP-AES with AAS. Applications.

X-ray fluorescence spectroscopy: Principle. Instrumentation: wavelength and energy dispersive devices. Sources and detectors. Comparison between wavelength and energy dispersive techniques. Sample preparation for XRF. Matrix effects in XRF. Applications in qualitative and quantitative analysis.

*Particle induced X-ray emission (PIXE):*Basic principle, Instrumentation and applications.

*Electron microscopy:*Principle, instrumentation and applications of scanning electron microscopy (SEM) and transmission electron microscopy (TEM)

Unit-III:Electrochemical methods of analysis-III 15h

Ion selective electrodes: Theory of membrane potential. Types of ion-selective electrodes. Construction of solid state electrodes, liquid membrane electrodes, glass membrane electrodes and enzyme electrodes, Selectivity coefficients, Glass electrodes with special reference to H^+, Na^+ and K^+ ions. Applications of ISE in analysis of environmentally important anions like F^-, Cl^-, Br^-, I^-, NO_3^- and CN^-. Advantages of ISE.

Coulometry: Principle. Coulometry at constant potential and constant current. Instrumentation. Applications and advantages of coulometric titrations.

Electrochemical microscopy: Introduction to scanning probe microscopy (SPM), scanning tunneling microscopy (STM), atomic force microscopy (AFM) and scanning electrochemical microscopy (SECM).

Unit-IV: Thermal methods of analysis 15h

Introduction to different thermal methods, Thermogravimetry (TG and DTG), Static thermogravimetry, quasistatic thermogravimetry and dynamic thermogravimetry, Instrumentation-Balances, X-Y recorder, Stanton-Redcroft TG-750, Thermogram, Factors affecting thermogram, Applications of thermogravimetry, Differential Thermal Analysis (DTA)- Theories, DTA curves, Factors affecting DTA curve, Applications of DTA, simultaneous determination in thermal analysis, Differential Scanning Calorimetry (DSC)- Introduction, Instrumentation, DSC curves, factors affecting DSC curves, applications, Thermogravimetric titration-Theory, Instrumentation and applications.

Semester IV

Paper XIV(Code: 4T2)

Special II-Analytical Chemistry

60h (4h/week) 15h/ unit 80 Marks

Unit-I: Pharmaceutical and clinical analysis 15h

Requirements of a quality control laboratory for pharmaceutical units.

Structures, category, identification (qualitative) and assay (quantitative) of following drugs

1. Antibiotics: Amoxycillin, Azithromycin, Cefixime, Levofloxacin

2. Antihistamine: Cetirizine, Cinnarizine
3. Vitamins: Thymine hydrochloride (Vitamin-B_1) Riboflavin (Vitamin-B_2), Ascorbic acid (Vitamin-C)
4. Analgesics: Diclofenac, paracetamol, Aspirin.

Composition of blood, sample collection for blood and urine, clinical analysis, Immuno Assay-RIA, Setting up of RIA and applications, Fluorescence Immunoassay, Enzyme immunoassay, Blood gas analyzer, Trace elements in the body.

Unit-II: Soil analysis and coal analysis 15h

Soil analysis- Classification and composition, pH and conductivity, analysis of constitutents such as nitrogen, phosphorous, potassium and microconstitutents (Zn and Cu).

Coal analysis- Proximate analysis (moisture content, ash content, volatile matter, fixed carbon). Ultimate analysis (carbon, hydrogen, sulphur, nitrogen, oxygen content). Combustion of carbonaceous fuel- Flue gas. Calorific value and its units, Bomb calorimeter.

Unit-III: Corrosion and corrosion analysis 15h

Definition, draw backs and theories of corrosion-dry and wet corrosion, Different types of corrosion-Pit, Soil, chemical and electrochemical, intergrannular, waterline, microbial corrosion, measurement of corrosion by different methods, factors affecting corrosion, passivity, galvanic series, protection against corrosion, design and material selection.

Unit-IV: Automation in analytical chemistry 15h

Automation in the laboratory, Principle of automation, automated instruments, classification, continuous analyzer, automatic instruments, semiautomatic instruments GeMSAEC Analyzer, Flow Injection Analysis (FIA), Dispersion coefficient, Factors af fecting Peak Height, microprocessor based instruments, Numericals based on above.

Hyphenated techniques: Introduction to GC-MS, LC-MS, ICP-MS and MS-MS (Tandem) spectrometry.

Semester IV

Practical-VII (Code: 4P1)

Analytical Chemistry Special Practical

12 h /week Marks: 100

A. Organoanalytical chemistry

1. Estimation of sulphur, nitrogen, phosphorous,chlorine in organic compound.
2. Estimation of phenol.
3. Estimation of aniline.

B. Separation techniques

Ion exchange

1. Separation and estimation of zinc and magnesium/cadmium in a mixture on anion exchanger.
2. Separation and estimation of chloride and iodide in a mixture on anion exchanger.
3. Determination of total cation concentration in water.

Solvent extraction

1. Estimation of Copper using Na-DDC.
2. Estimation of Iron using 8-hydroxyquinoline.
3. Estimation of Nickel using DMG.
4. Estimation of Cobalt using 8-hydroxyquinoline.
5. Estimation of Nickel by synergistic extraction with 1,10-phenanthroline and dithizone.

Paper chromatography

1. Separation and estimation of copper and nickel in a mixture.
2. Separation and estimation of cobalt and nickel in a mixture.

Thin layer chromatography

1. Separation and estimation of bromophenol blue, congo red and phenol red in a mixture.

2. Separation and estimation of metal ions in mixture.

C. Water analysis

1. *Mineral analysis*: Ttemperature, pH, conductivity, turbidity, solids, alkalinity, chloride, fluoride, sulphate, hardness
2. *Demand analysis*: DO, COD
3. *Heavy metals*: Fe, Cd and Pb

D. Demonstrations

1. Gas chromatography
2. HPLC

List of books:

1. Essentials of Nuclear Chemistry: H. J. Arnikar (Willey Eastern Ltd)
2. Substoichiometry in Radioanalytical Chemistry: J. Ruzicka and J Stary (Pergamon Press)
3. Thermal analysis: Blazek (translated by J. F. Tyson, Van Nostrand)
4. Instrumental Methods of Analysis: Willard, Meriit and Dean(Van Nostrand)
5. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
6. Vogel's Text Book of Quantitative inorganic Analysis: Bassett, Denney, Jeffery and Mendham (ELBS)
7. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
8. Atomic Absorption Spectroscopy: Robinson (Marcel Dekker)
9. Instrumental Methods of chemical Analysis: Braun (Tata McGraw-Hill)
10. Radiochemistry: A. N. Nesmeyanov (Mir Publications)
11. Analysis of Water: Rodier
12. Ion selective electrods: Koryta (Cambridge University Press)
13. Instrumentation in analytical chemistry: Borman (American Chemical Society)
14. Industrial Chemistry: Arora and Singh (Anmol Publications)
15. Diffraction Methods: John Wormald (Clarendon Press)
16. Electroanalytical Chemistry: Bard (Dekker)
17. Analytical Chemistry by Open Learning (Wiley)
18. An Introduction to Electron Diffraction: Beeston (North Holand Publishing Co.)
19. Material Science and Engineering: V. Raghavan (Printice-Hall of India)
20. Practical Physical Chemistry: J. B. Yadav (Goel Publishing House)
21. Indian Pharmacoepia, Vol-I, II and III.

Semester IV

Paper XV (Code: 4T3)

Elective- Nuclear Chemistry

60 h (4 h per week): 15 h per unit — 80 Marks

Unit-I: Radiation Chemistry, Radiolysis — 15h

Measurement of dose. Dosimetric terms and units (Roentgen, REM, Rad, Gray, Sievert), inter conversions, calculation of absorbed dose-various types of dosimeters, chemical dosimeters (Fricke, Ceric sulphate and FBX), experimental methods, TLD badges, Radiolysis-definition, process, Radiolysis of water and aqueous solutions, hydrated electron,

Effect of radiation on biological substances, genetic effects, radiation effects on organic compounds (Halides-carboxylic acids), polymers, nitrates and solid thermoluminescence.

Unit-II: Hot Atom Chemistry and Radiochemistry — 15h

Recoil energy and calculations, Szilard Chalmers effects, Kinetics, primary and secondary retention-effect of various factors on retention and its uses, Mossbauer effect- principle, instrumentation and chemical applications,

Unit-III: Radioanalytical techniques — 15h

Neutron sources, Neutron activation analysis, principle, methodology and application for trace analysis, Isotope dilution analysis-principle and application, Isotopic exchange reaction, mechanism

and application in use of radioisotopes and tracers, radioactive dating based on carbon-14 and lead isotopes.

Unit-IV: Radiopharmaceuticals 15h

Radioimmunoassay (RIA), discovery, principle, set up of RIA, Principle of Immunoradiometric assay (IRMA), principle and set up, Radiopharmaceuticlas, classification of products, preparations, quality control aspects, ^{99}Mo-^{99m}Tc generator, Cylotron based products, PRT studies, Therapeutic applicatyions , Radiotherapy

Semester IV

Paper XV (Code: 4T3)

Elective- Environmental Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Water Pollution 15h

Pollutants- Types of pollutants, sources of water pollution, sampling, preservation and storageof water sample, physico –chemical, organoleptic and chemical analysis of water, electro-analytical,optical (UC-visible spectrophotometry, AAS, flame photometry, XRF, ICPAES), chromatographic (GC and HPLC) and neutron activationmethods of analysis of Co, Ni, Cu, Fe, Mn, Zn, Cd, Pb, Hg, As, Cl^- ,F^-, $SO4^{--}$,PO_4^-, NO_3^-. Historical development of detergents, chemistry of soaps and detergents.

Unit-II: Air Pollution 15h

Natural versus polluted air, air quality standards, air sampling, analysis and control of Particulates, Chemistry and analysis of SOx, NOx, CO, ozone, hydrocarbons, CFCs.Chemistry of gaseous, liquid and solid fuels- gasoline and additives, antiknock agents.Air pollution control—control of automobile emission and control measures in thermal power stations.

Unit-III: Soil Pollution 15h

Types and sources of soil pollution, classification of soil pollutants, impact of soil pollutionon air quality, Specifications for disposal of sewage and effluent on land for irrigation andground water recharge. Methodology of waste water disposal on land in India. Impact of usage of land for solid waste disposal both municipal solid waste and industrial solid wastes (fly ashfrom thermal power station, lime sludge from paper and pulp industry), cause of soil erosion,effects of soil erosion, conservation of soil, control of soil pollution.

Unit-IV: Solid waste pollution 15h

Sources, types and consequences, classification of wastes- domestic, industrial, municipal, hospital, nuclear and agricultural and their methods of disposal. Transfer and transport,Recycle, reuse, recovery, conversion of solid wastes -energy / manure.Analysis and monitoring of pesticides.

Impact of toxic chemicals on enzymes, Biochemical effects of As, Cd, Pband Hg, their metabolism, toxicity and treatment.

Semester IV

Paper XV (Code: 4T3)

Elective- Polymer Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

Unit I: Polymerization 15h

Types of polymerization, addition-chain, free radical, ionic polymerization, step polymerization, electropolymerization, ring-opening polymerization.

Unit II: Techniques of polymerization 15h

Techniques of polymerization-suspension, emulsion and bulk polymerization, coordination, polymerization mechanism of Ziegler Natta polymerization, stereospecific polymerization, interfacial polycondensation, mechanism of polymerization.

Unit III: Characterization of polymers 15h

Electronic, IR and NMR spectral methods for characterization of polymers (Block and Graft)

Thermal methods-TGA, DTA, DSC, thermomechanical and X-ray diffraction study, Block and Graft copolymers, random, block, graft co-polymers, methods of copolymerization.

Unit IV: Specific polymers 15h

A) Biomedical polymers: Contact lens, dental polymers, artificial heart, kidney and skin.

B) Inorganic polymers: Synthesis and application of silicon, phosphorous and sulphur containing polymers.

C) Coordination polymers: Synthesis and applications of coordination polymers.

Semester IV

Paper XV (Code: 4T3)

Elective- Medicinal Chemistry

60 h (4 h per week): 15 h per unit 80 Marks

UNIT-I: 15 h

A] Drug rules and drug acts, Overview of Intellectual property right, Indian and International framework for patent protection.

B] Statastical method: For sampling and interpretation of results, Statastic in quality control, T-Test, F-Test, Validation of analytical methods as defined proceeding USP Radio immune analysis, Investigational drugs.

C] Antidiabetic Agents- Type-I and Type-II diabetes, Insulin, thiazolidinediones, Synthesis of ciglitazone.

UNIT-II: 15 h

A] Anti-Viral agents: Inroduction, viral diseases, viral replication, and transformation of cells, investigation of antiviral agents,. Chemotherapy for HIV. Synhesis of: Idoexuidine, acyclovir ,amantadine and cytarabin.

B] Anti-malarial agents: Introduction, malarial parasite, and its life cycle, development of antimalarials, chemotherapy of malaria. Synthesis of: Chloroquin, primaquin, proguanil, and Quinacrine

C] Local Anti-infective drug: Introduction and general mode of action. Synthesis of sulphonamides, ciprofloxacin, norfloxacin, dapsone ,amino salicylic acid, isoniazid, ethionamide, ethambutal, econozole, griseofulvin.

UNIT-III: 15 h

A) Histamines and Antihistamic agents: Introduction, histamine H1-receptor antagonists. Inhibitors of histamine release. Synthesis of: alkyl amines, phenothiazines, piperzines derivatives.

B) Antibiotics: Introduction, β-lactam antibiotics, classification, SAR and chemical degradation of penicillin, cephalosporins-classification , tetracycline antibiotics-SAR,miscellaneous antibiotics. Synthesis of ampicillin, cephradine, methacycline,chloramphenicol

UNIT-IV: 15 h

A) Anthelminitics and antiamoebic drugs: Introduction to Helminthiasis, Anthelminitics, drugs used in cestode infection, drugs used in trematode infection, origin of antiamoebic drug, drugs used in nematode infection. Synthesis of: Clioquinol, Iodoquinol, Haloquinol, Dichlorphen, Niclosamide.

B) Anti-inflammatory drugs: Introduction, etiology of inflammatory diseases. The inflammatory response, biochemical response. Synthesis of: Phenyl butazone and its derivatives, pyrazolone derivatives, pyrole and indole acetic acid derivatives.

Semester IV

Paper XVI (Code; 4T4)

Foundation Course–IIApplied Analytical Chemistry-II

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Water treatment 15h

Hardness of water and types of hardness. Problems due to hardness. Removal of hardness by lime-soda process, Zeolite process and synthetic ion-exchange resins. Principle, instrumentation and comparison of these three processes. Numericals based on hardness removal. Desalination of sea-water.

Unit-II: Polymer chemistry and leather analysis 15h

Polymer chemistry: Definition, classification, co-polymers, conducting polymers, determination of acid value, saponification value, iodine value, molar mass by end group analysis- amide and hydroxyl, molecular weight by viscosity method, glass transition temperature of polymers, TGA and DTA studies of polymers.

Analysis of leather: Determination of moisture, acid, free sulphur, total ash, chromic oxide in leather, tensile strength and stretch of leather.

Unit-III: Metallurgy

Ores and minerals, General principles of extraction of metals from ores. Steps involved in metallurgical extraction. Purification and concentration of ores. Extraction of crude metal from concentrated ore-pyrometallurgy, hydrometallurgy and electrolytic processes. Refining of metal. Thermodynamic aspects of metallurgical processes and Ellingham diagram. Furnaces in metallurgy. Metallurgy of Cu, Ag, Au, Al and Fe.

Unit-II: Clinical analysis 15h

General composition of blood, Collection and storage of blood samples, Estimation of chloride, calcium, sodium, potassium and bicarbonate in blood sample. Qualitative tests for reducing sugar. Estimation of blood glucose, urea, uric acid, blood urea-nitrogen, total serum protein, serum albumin, serum creatinine, serum phosphate, serum bilirubin, serum cholesterol. Radioimmunoassay (RIA).

OR

Semester IV

Paper XVI (Code: 4T4)

Core Subject Centric –IISpectroscopy – II

60 h (4 h per week): 15 h per unit 80 Marks

Unit I: 15 h

A] Ultraviolet and visible spectroscopy: Natural line width, line broadening, transition probability, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels. General nature of band spectra. Beer- Lambert Law, limitations, Frank-Condon principle, various electronic transitions, effect of solvent and conjugation on electronic transitions, Fiesher Wooodward rules for dienes, aldehydes and ketones. Structure differentiation of organic molecules by UV Spectroscopy

B] Photoelectron spectroscopy: Basic principles, photoelectric effect, ionization process, Koopman theorem, PES and XPES, PES of simple molecules, ESCA, chemical information from ESCA, Auger electron spectroscopy.

Unit II: Nuclear magnetic Resonance Spectroscopy 15 h

Magnetic properties of nuclei, resonance condition, NMR instrumentation, chemical shift, spin spin interaction, shielding mechanism, factors affecting chemical shift, PMR spectra for different types of organic molecules, effect of deuteration, complex spin spin interaction(1^{st} order spectra), stereochemistry, variations of coupling constant with dihedral angle, electronegativity, Karplus equation etc., classification of molecules as AX, AX_2, AMX, A_2B_2, Shift reagents. NMR studies of ^{13}C, chemical shift in aliphatic, olefinic, alkyne, aromatic, heteroatomic and carbonyl compounds, ^{19}F, ^{31}P. Structure determination of organic molecules by NMR spectroscopy

Unit III: 15 h

A] Application of NMR spectroscopy: FT-NMR, advantages of FT-NMR, two dimensional NMR spectroscopy-COSY, HETCOR, NOSEY, DEPT, INEPT, APT, INADEQUATE techniques, Nuclear overhauser effect, use of NMR in medical diagnosis

B] Problems based on structure determination of organic molecules by using NMR (^{1}H and ^{13}C nuclei) data, Structure elucidation using combined techniques including UV, IR, NMR and mass spectrometry (based on data and copies of the spectra)

Unit IV**:** Diffraction techniques 15 h

X ray diffraction: Braggs condition, Miller indices, Laue method, Bragg method, Debye Scherrer method, identification of unit cells from systematic absences in diffraction pattern, structure of simple lattices and x-ray intensity, structure factor and its relation to intensity and electron density, absolute configuration of molecules.

Electron diffraction: scattering intensity vs scattering angle, Wierl equation, measurement techniques, elucidation of structure of simple gas phase molecules, low energy electron diffraction and structure of surfaces.

Neutron diffraction: Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques, elucidation of structure of magnetically ordered unit cell.

List of books

1] Spectroscopic identification of organic compound-RM Silverstein,GC Bassler and TC Morril, John Wally
2] Introduction to NMR spectroscopy-R. J. Abraham, J. Fisher and P Loftus Wiely
3] Application of Spectroscopy to Organic Compound-J. R. Dyer, Printice Hall
4] Organic Spectroscopy-William Kemp, ELBS with McMillan
5] Spectroscopy of Organic Molecule-PS Kalsi, Wiley, Esterna, New Delhi
6] Practical NMR Spectroscopy-ML Martin, JJ Delpench, and DJ Martyin
7] Spectroscopic Methods in Organic Chemistry-DH Willson, I Fleming
8] Fundamentals of Molecular Spectroscopy-CN Banwell
9] Spectroscopy in Organic Chemistry-CNR Rao and JR Ferraro
10] Photoelectron Spectroscopy-Baber and Betteridge
11] Electron Spin Resonance Spectroscopy-J Wertz and JR Bolten
12] NMR –Basic Principle and Application-H Guntur
13] Interpretation of NMR spectra-Roy H Bible
14] Interpretation of IR spectra-NB Coulthop
15] Electron Spin Resonance Theory and Applications-W gordy
16] Mass Spectrometry Organic Chemical Applications, JH Banyon
17] Spectroscopy- H. Kaur

Semester IV

Practical VIII **(**Code**:** 4PROJ1**)**

Project

12 h/week 100 Marks

Project is a part of practical examination. Project should be carried out by the student under the supervision of Guide/Teacher. The examination shall be conducted by External and Internal Examiners. Students are supposed to present their work either on LCD Projector / OHP or blackboard.

The division of marks will be as follows**:**

For written Project Work	: 40 Marks	- Evaluated jointly by External and Internal Examiners
Presentation	: 20 Marks	- Evaluated jointly by External and Internal Examiners
For Viva-Voce	: 20 Marks	- Evaluated by External Examiner
Internal Assessment	: 20 Marks	- Evaluated by Internal Examiner

Note**:** One external examiner shall be appointed for evaluation of group of 6 students**.**

Semester IV

Seminar**-**IV **(**Code**:** 4S1**)**

2 h /week Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 25 marks (1 Credit). Seminar should be delivered by the student under the guidance of concerned teacher on thetopic allotted by the teacher. The topic will be related to the syllabus. Marks will be allotted by a group of teachers.

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