SYLLABUS

For

PRE-Ph.D. COURSE WORK

(UNDER VIDYASAGAR UNIVERSITY)

RESEARCH CENTRE

MIDNAPORE CITY COLLEGE

(Recognized by UGC, Govt. of India,

Higher Education Department, Govt. of West Bengal

Affiliated to Vidyasagar University)

THRUST AREA:

BIODIVERSITY AND ENVIRONMENTAL STUDIES

Course Structure

Course	Paper Code	Subject	Full Marks	Unit	Distribution of Marks	Credit
Course I	**BES1**	Research Methodology and Research Ethics	50	I	Written: 40 (Exam Hours: 2)	4
				II	Assignment writing on any one (Practical): 10 Marks	
Course II	**BES2**	Computer Application and Statistical Methods	50	I	Written: 40	4
				II	Assignment writing on any one (Practical): 10 marks	
Course III	**BES3**	Literature Review and Data Management	50	-	Assignment to be Submitted* [*A Literature Review or data generated on the related research topic be submitted by each scholar duly signed and recommended by the Supervisor]	4
Course IV	**BES4**	Special Topics	50	-	Students will have a choice to select special topics amongst a list of subjects	4

Course I: Research Methodology and Research Ethics

Credit Hours: 60

[Written: 40 (Exam Hours: 2) + One Assignment: 10]

Code: BES 1 Full Marks - 50

3L+1T=4

Credit-4

Unit I [Marks 40]

Research Methodology:

1. Research: Definition, importance, meaning and characteristics. Steps in research.
2. Data: Definition, Sources and types, Data collection. Analysis of data.
3. Review of literature: Indian scenario, international scenario
4. Preparation of research proposal
5. Research report: Types (Open access publication, Database and Research metrics), Content, Styles and steps in drafting. Editing of draft, Thesis writing
6. Handling of Manuscripts, Text editing, Proof reading, Bibliography & index
7. Impact factor, Citation index, SCI, H-index, SCOPUS

Research Ethics and Laboratory Culture:

1. Mentor-mentee relationship
2. Research and Publication Ethics (RPE) with reference to plagiarism and detection of plagiarism
3. Culture and behavior in laboratory, basic communication.
4. Guidelines and regulations of research on human and animal models.
5. Bio-safety and laboratory waste management

Unit II- Practical [Marks 10]

Assignment writing on any one

- Review of articles
- Research proposal
- Sample design
- Data analysis

Course II: Computer Application and Statistical Methods

Credit Hours: 60

[Written: 40 (Exam Hours: 2) + One Assignment: 10]

Code: BES 2 Full Marks - 50

3L+1T=4

Credit-4

Group A [Marks 40]

1. Basic computer architecture, Operating system: latest version of WINDOWS, UNIX
2. Software's-use of MS word, MS-Power Point, and Latex.
3. MS EXCEL-Bar diagram, Pie diagram and line diagram
4. Software Packages: Origin, SPSS etc.
5. Normal probability distribution.
6. Test for goodness for fit for a proposed distribution.
7. Correlation of coefficient: simple linear, multiple linear, and partial.
8. Regression; simple, multiple and stepwise.
9. Counting statistics and error prediction

Group B-Practical [Marks 10]:

Assignment writing on anyone (Practical)

- Power point presentation on a research topic/proposal.
- Analysis of data using MS-Excel.
- Analysis of data on given statistical methods.

Course III: Literature Review and Data Management

Credit Hours: 60

[Written (one assignment): 50]

Code: BES 3 Full Marks - 50

3L+1T=4

Credit-4

A literature review or data generated on the related research topic can be submitted by each scholar duly signed and recommended by the Supervisor.

Course IV: Special Topics

Credit Hours: 60

[Written: 50 (Exam Hours: 2)]

Code: BES 4 Full Marks - 50

3L+1T=4

Credit-4

Students will choose one subjects from the options mentioned herewith:

Chemistry

[Students need to take any one course from following options]

1. Frontier in Organic Chemistry:

1. Green Chemistry: Principles of Green Chemistry, Examples, Renewables for Sustainability, Green Synthesis, Plant secondary metabolites, Terpenoids: Biogenesis, Biosynthesis, Triterpenoids as Renewable Nano-entities

2. Application of Spectroscopic Studies in Organic Chemistry: Advanced treatment of NMR , IR, UV-Visible and Mass Spectrometry.

4. Organic Synthesis: Application of photochemistry and radical chemistry in Organic Synthesis; Pericyclic Reactions; Total synthesis with retro synthetic analysis.

5. New Reagents For Organic Synthesis: Organotransition metal reagents: Introduction to non-metal reagents, Oxidizing reagents: Use of reagent such as Pyridinium Chloro Chromate (PCC), Pyridinium Fluoro Chromate (PFC), Swern oxidation, DCC oxidation, Tetrapropyl ammonium peruthenate and other oxidizing agents. Reducing agents: Reductions involving $NaBH_4$, $LiAlH_4$, $NaBH_3CN$, DIBAL and Red –Al.

6. Seminar lectures by students on a recently published paper in organic chemistry Suggested

Reading:

1. Molecular Gels: Materials with Self-Assembled Fibrillar Networks. Weiss, Richard G., Terech, Pierre (Eds.), 2006, Springer

2. Green Chemistry: Theory and Practice. Paul T. Anastas, John Charles Warner. Oxford University Press, 1998

3. Green Chemistry: Principles and Practice, P. Anastas, N. Eghbali, Chem. Soc. Rev. 2010, 301-312.

4. Molecular Mechanics, N. L. Allinger, Theoretical and Computational Models for Organic ChemistryFormosinho, S.J., Csizmadia, Imre G., Arnaut, Luìs G. (Eds.) pp 125-135; 1991, Springer

5. B.G. Bag, R. Majumdar, Self–assembly of renewable nano–sized triterpenoids,Chem. Rec. 2017, 17, 1, 1-34.

6. B. G. Bag, A. C. Barai, S. N. Hasan, S. K. Panja, S. Ghorai, S. Patra, Pure Appl. Chem S. Patra., 2020, 92, 567-577.

7. R. O. C Norman, J. M. Coxon, Principles of Organic Synthesis, 3rd edition, CRC Press, (2009)

8. T. Imamoto, Lanthanides in Organic Synthesis, Academic Press (1994).

9. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, 4th edition, Cambridge University Press, (2006)

10. J. Tsuji, Transition Metal Reagents and Catalysts: Innovations in Organic Synthesis, John Wiley & Sons Ltd. (2000)

11. S. Warren, P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd edition, John Wiley & Sons Ltd, (2009).

2. Advanced photophysics and Computational chemistry

Shapes of absorption band and Franck-Condon principle, Emission spectra, Environmental effect on absorption and emission spectra, Excited state dipole moment, Excited state acidity constant, Time resolved emission. Bimolecular collision and the mechanism of fluorescence quenching, Kinetics of collisional quenching: Stern-Volmer equation, concentration dependence of quenching, excimer & exciplex. Radiative energy transfer: Forster resonant energy transfer (FRET), photoinduced electron transfer.

Computational Chemistry:

Semi-empirical method: MNDO, AM1, PM3 Ab-initio implementation of Hartree-Fock MO theory, Basis sets, key technical and practical points of HF theory. General performance overview of ab-initio HF theory. Density Function theory: Theoretical motivation, philosophy, Kohn-Sham self-consistent field methodology. Advantages and disadvantages of DFT compare to MO theory. General performance overview of DFT, case study.

References:

1. Principles of fluorescence spectroscopy by J. R. Lakowicz; CRC Press

2. Photophysics of Aromatic Molecules by J. B. Birks; Wiley Interscience

3. Essential of computational chemistry by Christopher J. Cramer; Wiley

3. Advanced Inorganic and BioInorganic Chemistry

Application of advanced techniques to study micro and macromolecular interaction Interaction of complexes with DNA, RNA and Serum proteins (Bovine serum albumin (BSA) and Human serum albumin (HSA), Human haemoglobin and myoglobin etc.) monitored by (a) UV-Vis spectroscopy (b) UV-thermal melting (c) Fluorescence spectroscopy (d) Cyclic voltammetry (e) Circular dichroism spectroscopy (CD) and (f) Isothermal titration calorimetry (ITC). Interaction between nanoparticle and Serum proteins (Bovine serum albumin (BSA) and Human serum albumin (HSA), Human haemoglobin and myoglobin etc.) monitored by (a) UV-Vis spectroscopy;(b) UV-thermal melting (c) Fluorescence spectroscopy and 3D fluorescence spectroscopy; (d) DLS and Zeta potential measurement study; (e)IRSpectroscopy;(f) Circular dichroism spectroscopy (CD) and (f) Isothermal titration calorimetry (ITC).

Advanced Organometallic Chemistry

Representative organometallic reactions with a special reference to the reaction mechanism. Stereochemical non-rigidity and fluxional behaviour of organometallic compounds. Metallocene: η5 - Cyclopentadienyl metal complexes, η6 -Arene metal complexes, Catalysis by organometallic compounds: Wilkinson's catalyst, Tolman's catalytic loops; Synthesis gas, Water gas shift reaction, Synthesis of methanol, Hydroformylation (oxo process), Hydrogenation of unsaturated compounds, Monsanto acetic

acid process, Wacker process, Synthetic gasoline, Fischer-Tropsch process and Mobil process; Polymerisation, Oligomerisation and metathesis reactions of alkenes and alkynes; Ziegler-Natta catalysis.

Magnetic Properties of Materials

Ferromagnetism, Ferrimagnetism, Antiferromagnetism, Magnetic Susceptibility vs. Temperature, Metamagnet, Superparamagnet, Paramagnetism in Metal Complexes, Hysteresis Curves, Antiferromagnetism in Metal Oxides, Super-exchange, Magnetic Ordering in Rock Salt Oxides, Magnetic interaction in polynuclear metal complexes, MOFs as magnetic materials.

Suggested Readings:

1. In Drug-DNA Interaction Protocols, Second Edition, Yang Liu, W. David Wilson (auth.), Keith R. Fox (eds.) Springer New York.

2. Circular Dichroism and the Conformational Analysis of Biomolecules Jen Tsi Yang (auth.), Gerald D. Fasman (eds.) Springer US.

3. Analytical Applications of Circular Dichroism, Volume 14 1st Edition, N. Purdie H.G. Brittain, Elsevier Science.

4. B. D. Gupta and A. J. Elias 2010, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, Universities Press, Hyderabad.

5. J. P. Collman, L.S. Hegedus, J.R. Norton and Richard G. Finke, 1987, Principles and Applications of Organotransition Metal Chemistry, 1st Edtion, University Science Books, Mill Valley, California.

6. Gerard Jaouen (Ed.), 2005, Bioorganometallics, Wiley-VCH.

7. Elements in Magnetochemistr, R. L. Dutta and A. Shyamal, Affiliated East-West Press.

8. Solid State Physics, S. O. Pillai, New Age International Publishers.

4. Biophysical Chemistry and Surface Chemistry

Thermodynamics in Biochemistry (Fundamentals and Applications); Biopolymers (Proteins, Enzymes, DNA, Carbohydrates); Biomembranes (Structure and Function); Active transport and passive transport, Multiple equilibria, Specific examples of multiple equilibria, Transport processes; General features of transport processes; Optical systems for the study of transport processes.Self-organizing systems: Their interactions, Physicochemical Properties, Different Characterization techniques, Applications. Preparation, Characterization and Application of nanoparticles Surface and Biophysical Techniques: Calorimetry, CD, SEM, TEM, EDAX, DLS, Gel Electrophoresis, Radioactivity, XPS.

Suggested Readings:

1. Thermodynamics and an Introduction to Thermodynamics, H. B. Callen

2. Principles of Physical Biochemistry, K. E. van Holde, C. Johnson, P. S. Ho

3. Physics and Chemistry of Interfaces, Hans-Jürgen Butt, Karlheinz Graf, Michael Kappl

4. Physical Chemistry of Surfaces, Arthur W. Adamson, Alice P. Gast

5. Physical Chemistry of Macromolecules, C. Tanford

6. Polymer Chemistry, P. J. Flory

7. Nanocrystals: Synthesis, Properties and Applications, C.N.R. Rao, P. John Thomas, G. U. Kulkarni

5. **Biological Organic Chemistry and Application of advanced techniques to Study Modes of Interactions**

Nucleic Acids: DNA; Structural features of various forms of DNA; RNA; Various types of RNA and their structural properties and function.

Alkaloid-Nucleic Acid Interactions and its Implications for Drug Design: Isoquinoline alkaloids and their medicinal properties; Binding of small molecules to nucleic acids; Interaction of berberine, palmatine, coralyne, jatrorrhizine and sanguinarine with various forms of natural and synthetic DNAs and RNAs; Binding of derivatives of the alkaloids with nucleic acids; The mode, mechanism and thermodynamics of the alkaloid-nucleic acid binding interaction monitored by (a) UV-Vis spectroscopy;(b)UV-thermal melting (c) Fluorescence spectroscopy; (d) Cyclic voltammetry ; (e) Circular dichroism spectroscopy (CD) and (f) Isothermal titration calorimetry (ITC).

Suggested Readings:

1. In Drug-DNA Interaction Protocols, Second Edition, Yang Liu, W. David Wilson (auth.), Keith R. Fox (eds.) Springer New York

2. Circular Dichroism and the Conformational Analysis of Biomolecules Jen Tsi Yang (auth.), Gerald D. Fasman (eds.) Springer US

3. Analytical Applications of Circular Dichroism, Volume 14 1st Edition, N. Purdie H.G. Brittain, Elsevier Science

4. Biophysical, Chemical, and Functional Probes of RNA Structure, Interactions and Folding: Part A Andrew L. Feig, in Methods in Enzymology. Elsevier

5. Data Processing Handbook for Complex Biological Data Gauri Misra, Academic Press

6. Nucleic acids structure and recognition, by Stephen Neidle, Oxford University Press, 2002.

7. Principles of Nucleic Acid Structure by Stephen Neidle, 1st Edition, Academic Press.

6. **Spectroscopic Techniques in Chemistry**: Electronic Spectroscopy: General principles, Electronic absorption by molecules, absorption peaks and molar absorptivity, absorption and intensity shifts. Selection rules and their implications. Instrumentation: analytical applications: qualitative and quantitative analyses. Electronic spectra of inorganic and organic compounds. Infrared Spectroscopy: principles, factors influencing Vibrational frequencies, preparation of samples, the range of IR radiation, selection rules. Instrumentation: representation of spectra, dispersive and Fourier- transform IR– Spectroscopies. Application of IR Spectroscopy to inorganic and organic compounds. Raman Spectroscopy: principles, normal, resonance and laser Raman Spectroscopies. Structure determination by symmetry selection rules

(normal coordinate analysis). Application of Raman Spectroscopy to structural chemistry; Nuclear magnetic resonance Spectroscopy: General principles, sensitivity of the method, CW and FT-NMR, Instrumentation. Application in chemical analysis (with special reference to 1H – NMR): Chemical shift, spin-spin splitting, area of peak, shift reagents, off-resonance decoupling, Nuclear Overhauser Effect, solid state and gas phase NMR spectra. Introduction to fluorescence, effects of solvents on fluorescence spectra, polarization of emission, measurements of fluorescence polarization. Timeresolved fluorescence Spectroscopy. Time dependent decays of fluorescence anisotropy. Mass spectrometry: Principles, advantages and limitations of Mass Spectrometry. Instrumentation, Methods of ionization, Metastable ions. Theory of Mass Spectrometry; Structure elucidation of inorganic and organic compounds; Mössbauer Spectroscopy: The Mössbauer Effect, the Mössbauer nuclei, chemical isomer shift, quadrupole splitting, magnetic hyperfine interaction. Elucidation of electronic structure of 57Fe, 119Sn compounds using Mössbauer data, Mössbauer of biological systems.

Suggested Readings:

1. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to Spectroscopy, 3rd edition, Thomson Brooks/Cole, (2000)

2. C. N. Banwell, Fundamentals of Molecular Spectroscopy, 4th edition, Tata Magraw Hill, (1994)

3. R. M. Silverstein, G. C. Bassler, C. Morril, Spectrometric Identification of Organic Compounds, 5th edition, John Wiley & Sons, (1991)

4. J. R. Dyer, Application of absorption Spectroscopy of organic compounds, Prentice Hall of India Pvt. Ltd. (2004)

Computer Sciences

1 : Discrete Structures and Optimization:

Mathematical Logic,.Sets and Relations:,Counting, Mathematical Induction and Discrete Probability, Group Theory, Graph Theory, Boolean Algebra, Optimization: Linear Programming,

2 : Computer System Architecture

Digital Logic Circuits and Components, Data Representation, Register Transfer and Microoperations: Basic Computer Organization and Design, Programming the Basic Computer, Microprogrammed Control,Central Processing Unit, Pipeline and Vector Processing, Input-Output Organization,Memory Hierarchy,Multiprocessors,

3 : Programming Languages and Computer Graphics Language Design and Translation Issues,Elementary Data Types Programming in C,mObject Oriented Programming,Programming in C++,Web Programming: Computer Graphics, 2-D Geometrical Transforms and Viewing, 3-D Object Representation, Geometric Transformations and Viewing.

4: Database Management Systems

Data Modeling,SQL, Normalization for Relational Databases,Enhanced Data Models,Data Warehousing and Data Mining,Big Data Systems

5: System Software and Operating System

System Software,Basics of Operating Systems,Threads,CPU Scheduling,Deadlocks,Memory Management,Storage Management,File and Input/Output Systems,Security,Virtual Machines, Linux Operating Systems,Windows Operating Systems,Distributed Systems,

6 : Software Engineering

Software Process Models, Software Requirements,Software Design,Software Quality,Estimation and Scheduling of Software Projects,Software Testing.

7 : Data Structures and Algorithms

Data Structures,Performance Analysis of Algorithms and Recurrences, Design Techniques, Lower Bound Theory, Graph Algorithms,Complexity Theory,Selected Topics,Advanced Algorithms.

8 : Theory of Computation and Compilers

Theory of Computation, Regular Language Models,Context Free Language,Turing Machines (TM), Unsolvable Problems and Computational Complexity, Syntax Analysis, Semantic Analysis, Run Time System,Intermediate Code Generation, Code Generation and Code Optimization.

9 : Data Communication and Computer Networks

Data Communication, Computer Networks, Network Models, Functions of OSI and TCP/IP Layers, World Wide Web (WWW) ,Network Security,Mobile Technology, Cloud Computing and IoT.

10. Artificial Intelligence (AI)

Approaches to AI,Knowledge Representation,Planning, Natural Language Processing, Multi Agent Systems, Fuzzy Sets,Genetic Algorithms (GA), Artificial Neural Networks (ANN).

Mathematics

[Students need to choose any two courses from the options mentioned below]

1. **Advanced Functional Analysis**

A. Revision: Normed linear spaces, Banach spaces, Hahn-Banch theorem, open mapping and closed graph theorems, principle of uniform boundedness, boundedness and continuity of linear transformations, dual space, embedding in the second dual, Hilbert spaces, projections, orthonormal basis, Riesz-representation theorem, Bessel's inequality, Persaval's identity, self-adjoined operators, normal operators, unitary operators.

B. Spectral theory in normed linear spaces, Resolvent set and spectrum, Spectral properties of bounded linear operators, Properties of resolvent and spectrum, Spectral mapping theorem for polynomials. Spectral radius of a bounded linear operator on a complex Banach space.

2. **Complex Analysis**

A. Revision: Analytic functions, Path integrals, Winding number, Cauchy integral formula and consequences. Open mapping theorem, Isolated singularities, Residue theorem, Liouville theorem.

B. Casorati-Weierstrass theorem, Picard's theorems, Mobius transformations Schwartz lemma, External metrics, Riemann mapping theorem, Argument principle, Rouche's theorem. Runge's theorem, Infinite products, Weierstrass p-function, Mittag-Leffler expansion.

3. **Commutative Algebra**

A. Revision: Basic concepts of groups, rings and fields.

B. Prime ideals and maximal ideals, Zariski topology, Nil and Jacobson, radicals, Localization of rings and modules, Noetherian rings, Hilbert Basis theorem, modules, primary decomposition, integral dependence, Noether normalization lemma, Krull's principal ideal theorem, Hilbert's Null-stellensatz, Structure of Artinian rings, Dedekind domains. Introduction to Algebraic Number Theory. Discriminants of number field. Factorization of ideals. Finiteness of class number. Euclidean number rings.

4. **Advanced Topology:**

A. Revision: Elements of topological spaces, continuity, convergence, homeomorphism, compactness, connectedness, separation axioms, first and second countability, separability, sub- spaces, product spaces, quotient spaces, subspaces, product spaces, quotient spaces, Tychonoff's theorem, Urysohn's metrization theorem.

B. Definition, Basic properties including translations in topological groups, neighbourhood system of identity, separation properties, uniform structure on topological groups.

5. **Differential Equations**

A. Revision: Linear system of ODE, symptotic stability, existence uniqueness theorems. Elementary Practical ODEs. general theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function. Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order

PDEs, classification of second order PDEs, general solution of higher order PDEs with constant coefficients, method of separation of variables for Laplace, Heat and Wave equations.

B. Classification and Characteristics of Higher Order PDFs: Cauchy-Kovalevskaya Theorem. Holmgren's Uniqueness Theorem. Conservation Laws and Shocks systems in one dimension: conservation laws, weak solution, Lax Shock Solution, Riemann Problems, Dirichlet Problem. Maximum Principles for parabolic equations; (i) weak maximum principle, (ii) strong maximum principle.

6. **Numerical Analysis**
   A. Revision: Numerical solutions of algebraic equations, method of iteration and Newton-Raphson method, rate of convergence, solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, finite differences, Lagrange, Hermite and spline interpolation, numerical differentiation and integration, numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.
   B. Approximation of functions, General function spaces, Least square approximation, Minimax approximation, orthogonal polynomials, approximation with rational functions, boundary value problems, Finite difference method, cubic spline method. Difference scheme based on quadrature formulas, solution of tridiagonal system, Non-linear boundary value problems, convergence of difference schemes, linear Eigen-value problems. Numerical solution of integral equation. Partial Differential Equations: Parabolic, Elliptic and Hyperbolic differential equations subject.
7. **Inventory Modeling and Optimization**
   A. Revision: Deterministic inventory models of uniform rate of demand and non-uniform rate of demand. Economic lot-size with finite rate of replenishment. Economic order quantity models with constant rate of demand. Production lot size model with shortage. Probabilistic inventory models, Fixed order quantity model. Probabilistic order–level system with constant lead time. Instantaneous demand no set-up cost model and Uniform demand no set-up cost model.
   B. Inventory control of style goods and perishable items. Production planning for unreliable production systems. Integrated production, quality and maintenance models. Production planning and inventory control in fuzzy environment. Supply chain-definition, decision phases, process view. Centralized supply network versus decentralized operation. Coordination. Bullwhip effect. Multi-echelon supply chains. Simple models of supply chain management. Solving inventory/supply chain management problem using Genetic Algorithms (GAs).
8. **Nonlinear Analysis and Optimization**
   A. Revision: Convex sets, convex hulls, closure and interior of a set, separation and support of sets, convex cones and polarity, polyhedral sets, extreme points, and extreme directions, Linear programming and the Simplex method.
   B. Convex functions and generalizations, definitions and basic properties, sub gradients of convex functions, differentiable convex functions, minima and maxima of convex functions, generalizations of convex functions, Optimality conditions and duality, the Fritz John and Karush-Kuhn-Tucker optimality conditions, unconstrained problems, problems with inequality constraints, Problems with equality constraints, second-order necessary and sufficient optimality conditions

for constrained problems. Constraint qualifications, cone of tangents, other constraint qualifications, problems with inequality and equality constraints, Lagrangian duality and saddle point optimality conditions Lagrangian dual problem, duality theorems and saddle point optimality conditions, properties of the dual function, formulating and solving the dual problem, getting the primal solution, Linear and Quadratic programs.

9. **Transforms and Integral Equations**

   A. Revision: Laplace transforms, inversion formula of Laplace transform, Fourier transforms; sine and cosine transform, inverse Fourier transform, transform of elementary functions, transform of derivatives, inverse transform, convolution theorem, application, ordinary and partial differential equations, application to ordinary and partial differential equations, linear integral equation of the first and second kind of Fredholm and Volterra type, solutions with separable kernels, characteristic numbers and eigenfunctions, resolvent kernel.

   B. Occurrence of integral equations in classical mechanics, ordinary differential equations, partial differential equations. Occurrence in continuum mechanics (elasticy, fluid mechanics). Singular integral equations, Abel integral equations, solutions, Cauchy singular integral equations, solutions, applications.

10. **Probability & Statistics**

   A. Revision: Sample space, discrete probability, independent events, Bayes theorem, random variables and distribution functions (univariate and multivariate), expectation and moments, independent random variables, marginal and conditional distributions, characteristic functions, probability inequalities (Tchebyshef, Markov, Jensen), modes of convergence, weak and strong laws of large numbers, central limit theorems.

   B. Markov chains with finite and countable state space, classification of states, limiting behavior of n-step transition probabilities, stationary distribution, standard discrete and continuous univariate distributions, sampling distributions, standard errors and asymptotic distributions, distribution of order statistics and range, methods of estimation, properties of estimators, confidence intervals, tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests, analysis of discrete data and chi-square test of goodness of fit, large sample tests, simple non-parametric tests for one and two sample problems, rank correlation and test for independence, elementary Bayesian inference.

Geography

[A candidate will choose any one from the following courses]

Special Course - 1: Atmospheric Science and Climatology (Geography)

1. Elementary concepts: Vertical thermal structure and composition of the atmosphere, Gas laws and their application to the atmosphere; Atmospheric instability and convection-stability,
2. Tropical Meteorology and Climatology: Weather and climate; Components of the climate system
3. Climatology of air masses: Origin, movement and modification of air masses; fronts and convergence zones; weather associated with frontal zones.
4. Monsoons: Climatological features and seasonal evolution of Indian summer monsoon; principal rain bearing systems including monsoon depressions, lows; mid-tropospheric cyclones; intra seasonal variability of summer monsoon including active and break cycles; monsoon variability on interannual and decadal time scales; impacts from tropical oceanic drivers such as the ENSO and IOD; northeast monsoon.
5. Overview of the climatic history of the earth; theories of climatic changes.
6. Climatic change and climatic variability: local and planetary influences; Milankovitch cycles, eccentricity, tilt and precision cycles; internal feed backs; Dansgaard-Oeshger cycles; Thermohaline circulation and its effect on climate.
7. Paleoclimate archives: micro fossils; dendrochronology; sclerochronology; lake and ocean varve sediments; foraminifera; oxygen isotope stratigraphy; loess deposits; Ice cores - polar and tropical ice cores; speleothems; pollen grains.
8. Greenhouse effect in Earth's current climate; Global warming: Relevance of greenhouse gases and aerosols; other climate forcings; climate change scenarios IPCC report: Recent climate change and detection; future projection; mitigation; adaptation. Sea level change: modelling and predicting climate change.

Suggested Readings:

1. Paleoclimates: Understanding Climate Change Past and Present: Thomas Cronin
2. Climate and Evolution: William Diller Matthew
3. Principles of Paleoclimatology: Thomas Cronin
4. Climatic Changes; Their Nature and Causes: Ellsworth Huntington
5. Barrry, R. G., and R. J. Chorley, Atmosphere Weather and Climate, 9th edition, Routledge publishers, 2010.
6. Wallace, J. M., and P. V. Hobbs, Atmospheric Science: An Introductory Survey, 2nd edition, Elsevier Academic Press, 2006

Special Course - 2: Environmental Geomorphology (Geography)

1. Concept of Environmental Geomorphology (Definition, Scope, Content)
2. Environmental Impact on Flood Plains with special reference to India & West Bengal
3. Concept of Geomorphological Hazards with special reference to flood and landslide.

4. Environmental consequences of flood (Gangetic Basin) and landslide (Darjeeling)
5. Flood Plain Management-
6. Soft Engineering (Flood plain zoning, Restoration and afforestation)
7. Hard Engineering (Flood relief channels, straightening & channelization, Dams, Levees & Embankments, Flood walls)
8. Concepts of Marine Environmental process (Concepts & Contents)
9. Study of Coastal Habitats (Estuaries, Lagoons, Salt Marshes, Mangroves, Coral Reefs)
10. Coastal Dynamics with special reference to Odisha & West Bengal coastal tract.
11. Environmental Impact on coastal morphological changes.
12. Human Impact/ Man- Environment conflict along coastal tract of West Bengal; special emphasis on Digha (W.B) & Balashore (OD) coastal tract.

Suggested Readings:

1. Bloom, Arther L., (2003): Geomorphology – A systematic analysis of Late Cenozoic Landforms, 3rd Edn.
2. Brutsaert, W. (2005): Hydrology: An Introduction, Cambridge University Press, Cambridge.
3. Chorley, R., Schumm, S. and Sugden, D.E. (1994): Geomorphology, Methuen, London: 605p. Coch,N.K, (1994): Geohazards: Natural and… ,Prentice-Hall,
4. Englewood Cliffs Cook and Doorncamp. (1988): Geomorphology in Environment Management, London.
5. Faniran, A. and Jeje, L.K. (1983): Humid Tropical Geomorphology, Longman, London:
6. Goudie,A.(Ed)(1990):Geomorphological Techniques,2nd edition, Allen Unwin Crow's Nest(Australia).
7. Huggett,R(2006): Fundamentals of Geomorphology, Routledge, London.
8. Kale, V.S. and Gupta, A. 2001. Introduction to Geomorphology, Orient Longman Ltd., Hyderabad: 274p.
9. Knighton, D.1998: Fluvial Forms and Processes: A New Perspective, Arnold, London: 385p. Lal, D. S., 2003. Oceanography, 3rd Edn. 288p.
10. Morisawa, M. (editor) 1994. Geomorphology and Natural Hazards, Elsevier, Amsterdam: 355p.
11. Morisawa, M. 1985. Rivers, Longman, London: 222p Murthy, K.S. 1998. Watershed Management in India, 3rd edition, Wiely Eastern Ltd. / New Age International Ltd., New Delhi: 198p
12. Newson, M. 1992. Land Water and Development, River Basin Systems and their Sustainable Management, Routledge, London: 350p.
13. Ollier, C.D. 1981: Tectonic Geomorphology, Longman Scientific & Technical, London.

<u>Special Course - 3</u>: Environmental Management and Sustainable Development (Geography)

1. Environment: Origin, concept, structure and composition.
2. Sustainable development: Concept, issues, approaches and challenges.
3. Energy and environment: Challenges, current concerns, energy policy and planning, green energy.
4. Globalization and environment: Global planning concerns, global responses, global movements and emerging concepts, green consumerism.
5. Environment Impact Assessment: Procedure of EIA, environment management standards.

6. Integrated environment management: urban and rural, sustainable habitat.
7. Participatory resource management: Forest, Coastal, Mountain, Irrigation and wetland.
8. Application of GIS in environment management: GIS Applications in wildlife. Use and values of GIS approaches to wildlife ecology and management integrating wildlife into forest and human land use systems. Land use land cover mapping.

Suggested Readings:

1. Agarwal, K.M., Sikdar, P.K., Deb., S.C (2005) A Text Book of Environment, Macmillan India Limited.
2. GIS and Remote Sensing in Hydrology, Water Resources and Environment by Yangbo Chen, International Association of Hydrological Sciences Published by IAHS, 2004
3. Introduction to Environmental Impact Assessment: Principles and Procedures, Process, Practice and Prospects by John Glasson, Riki Therivel, Andrew Chadwick Published by Taylor & Francis, 2005
4. Sharma, P. D. 1998, Ecology and Environment, Rastogi publication, Meerut Odum, E. P., (1971)
5. Fundamentals of Ecology, W. B., Saunders Company, Philadelphia.
6. Introduction to Environmental Impact Assessment: Principles and Procedures, Process, Practice and Prospects by John Glasson, Riki Therivel, Andrew Chadwick Published by Taylor & Francis, 2005
7. Introduction to Environmental Impact Assessment: A Guide to Principles and Practice by Bram F. Noble Published by Oxford University Press, 2005
8. Protected Areas of the World: A Review of National Systems by World Conservation Monitoring Centre, IUCN Commission on National Parks and Protected Areas, International Union for Conservation of Nature and Natural Resources, British Petroleum Company Contributor British Petroleum Company
9. Megadiversity Conservation: Flora, Fauna and Medicinal Plants of India's Hot Spots by AB Chaudhuri, D. D. Sarkar Published by Daya Books, 2004
10. Ex Situ Plant Conservation: Supporting Species Survival in the Wild by Edward O. Guerrant, Kayri Havens, Mike Maunder, Peter H. Raven Published by Island Press, 2004

<u>Special Course - 4</u>: Biodiversity, Conservation and Management (Geography)

1. Biodiversity: Concept, types, consumptive use, productive use, social, ethical, aesthetic and option values of biodiversity, Biodiversity as a natural resource.
2. Indian Biodiversity: Vegetational Zones, Zones of Faunal distribution, wealth of Indian hot-spots. Major protected areas & their importance.
3. Global Biodiversity: Major Biodiversity areas of the world, Biodiversity Hot Spots, Mega diversity Countries.
4. Urban Biodiversity: Biodiversity in cities & towns Concept of opportunistic species adapted to Human environs Anthropological factors in species dispersal Strays and feral populations.
5. Biodiversity Conservation: Levels of and Threats to Biodiversity, Endangered and Endemic species of India, Major protected areas & their importance.
6. In-situ and Ex-situ Conservation: Concept and practices.
7. Participatory Management for Biodiversity Conservations: Case Studies from Coastal, Mountain, Forest and Desert Ecosystem.

8. GIS approaches to wildlife ecology and management integrating wildlife into forest and human land use systems.

Suggested Readings:

1. Alexander, D. (1993): Natural Disasters, Research Press, New Delhi: 619p. Allaby, M. (1996): Basics of Environmental Science, Routledge, London: 297p.
2. Chapman J.L. and Reiss, M.J. (1993): Ecology: Principles and Applications, Cambridge University Press. Chapman, D. (1994): Natural Hazards, Oxford University Press, Melbourne: 174p.
3. Choudhuri, A.B. (2007): Endangered Wetland. Elsom, D.M. (1992): Atmospheric Pollution: A Global Problem, 2nd edn, Blackwell Pub. Co., London: 422p.
4. Farmer, A. (1997): Managing Environmental Pollution, Routledge, London: 246p. Marsh, W.M. and Grossa, J.M. (1996): Environmental Geography: Science, Landuse and Earth Systems, John Wiley & Sons.
5. Park, C. (1998): The Environment: Principles and Applications, Routledge, London:
6. Pickering, K. and Owen, L.A. (1997): An Introduction to Global Environmental Issues, 2nd edition, Routledge, London.
7. Prabhakar, V.R. (1998): Social and Community Forestry, Indian Pub. Distrb., New Delhi: 224p.
8. Roberts, N. (editor) (1994): The Changing Global Environment, 3rd edition, Blackwell Pub. Co., London: 531 p.
9. Robert M. May and Angela R. McLean (2007): Theoretical Ecology: Principles and Applications, Oxford University Press Barry cox;
10. Peter Dale Moore (2010): Biogeography an ecological and evolutionary approach, Hoboken, NJ: Wiley.

Special Course - 5: Society, Culture and Environment (Geography)

1. Society: Meaning, Nature and Characteristics. Types of Society: Tribal, Agrarian, and Industrial. Social Well-Being.
2. Social Change: Concept, Theories of Social Change. Factors of Social Change, Urban-Industrial Landscape.
3. Culture: Concept, Characteristics, Components, Functions. Evolution of Indian Culture. Cultural Diffusion.
4. Social Problems: Poverty, Crime, Unemployment, Labour Migration, Drug Abuse, Corruption, Homelessness, Violence against Women, Development and Displacement.
5. Indigenous Knowledge System: Socio-Cultural Belief Systems, Customs and Traditions, Forest and Natural Resource Management.
6. Development Pathways: The Equity Principal, Community Participation, Human Rights and Responsibilities, Responsibilities of Homo Sapiens towards other Living Creatures.
7. Sustainable Societal Development: Legal Provisions, International Initiatives – Local, Regional and Global Level, Role of NGOs and Community Participation, Sustainable Living, Solid Waste Management and Vermitech.
8. Role of Remote Sensing and GIS in Societal Development.

Suggested Readings:

1. Bist,B.S. and Panth,V.K(1998): Backward Communities in India, Rawat Pub.
2. Harvey. (2006): Readings in Indigenous Religion, Rawat Pub.
3. Hichcock,S.(2006): Geography of Religion, Rawat Pub.
4. Knox,Paul.L.(1975): Social Wellbeing: Human Spatial Perspectives, Oxford University Press.
5. Mahanti.M (ed) (1994): Class, Caste and Gender- Tribal Issues in India, Sage Pub.
6. Sahu, C. (2006): Encyclopedia of Indian tribes.
7. Tiwari, S.K. (1998): Antiquity of Indian Tribes.ISBN-81-7625-016-3.
8. Smith, S.J and Pain,R (Eds) (2010): Social Geographies, Sage, Los Angles
9. Perry, A.J and Perry, E.K (2010): Contemporary Society: An Introduction to Social Science, Pearson Education, Noida, India.
10. Guha-Banerje, S. (2001): Space, society and geography, Rawat Publication, Jaipur.
11. Norton, W (2006): Cultural Geography: Environments, Landscape, Identities and Inequities, Oxford University Press, Oxford.
12. Carter, J. And Jones, T. (1989): Social Geography: An Introduction to Contemporary Issues, Edward Arnold, London
13. De Blij H.J. (1996): Human Geography: Culture, Society and Space, John Wiley and Sons Inc., New York: 531 p.
14. Norton, W (2006): Cultural Geography: Environments, Landscape, Identities and Inequities, Oxford University Press, Oxford.
15. Mitchell, D. (2000): Cultural Geography: A Critical Introduction, Wiley.
16. Mike,C. (2000): Cultural Geography, Routledge, London Hussain, M. (2005): Cultural Geography, Anmol Publication, New Delhi.
17. Alison,B et.al (2003): Cultural Geography in practice, Arnold, New Delhi.
18. Singh, G.N and Nath, Kashi (2004): Cultural Geography-Form and Process, Concept Publication, New Delhi.
19. Jackson, A.K and et.al (2005): Cultural Geography: A critical dictionary of key concepts, Tauris, London

Special Course - 6: Tourism, Environment and Development (Geography)

1. Nature, Scope and Development of the Geography of Tourism and Heritage. Concept of Touristscape and Tourism Typologies, Tourism Infrastructure and super infrastructures.
2. Alternative tourism and Prospects: Ecotourism, Sustainable tourism, Heritage Tourism.
3. Theories of Travel Motivation: Socio-psychological models of Crompton and Iso-Ahola, Doxey's Irritation Index Model, Butler's Tourist Area Life Cycle Model, Hall's Theory of Tourism Market System.
4. Geography of Tourism: National, Regional and Global scenarios. Postmodern approaches in Tourism Geography.
5. The Tourism-Development Dilemma: Ecological impacts of Tourism. Tourism, Vulnerability and Global Environmental Change.
6. Globalization, Neoliberal Tourism and Socio-cultural Change. Tourism and Justice - Social and Environmental. Tourism-Poverty Nexus. Postcolonial Hegemony and Tourism.

7. Concepts And Approaches of Tourism Planning and Policy. International Governance of Tourism: Manila, Cape Town, Kerala Declarations.
8. Tourism in Indian: Tourism Policies, Evolving Tourism Circuits, Entrepreneurship, Product Development and Tourism Management. Crisis Communication System and Tourism Management.

Suggested Readings:

1. Ateljevic, I., Pritchard, A. and Morgan, N. (2007): The Critical Turn in Tourism Studies: Innovative Research Methodologies, Elsevier.
2. Beeton, S. (2006): Community Development through Tourism, Landlinks Press.
3. Buckley, R. (2009): Ecotourism: Principles and Practices, CABI 4. Butler, R. (2006): The Tourism Area Life Cycle (2 vols), Channel View Publications.
4. Butler, R. and Hinch, T. (2007): Tourism and Indigenous Peoples, Taylor and Francis.
5. Cooper, C. and Hall, C.M. (2008): Contemporary Tourism: An International Approach, Butterworth-Heinemann.
6. Cooper, C.P. (2003): Classic Reviews in Tourism, Channel View Publications.
7. Department of Tourism (2002): National Tourism Policy, Ministry of Tourism and Culture, Govt. of India.
8. Dwyer, L., Gill, A. and Seetaram, N. (2012): Handbook of Research Methods in Tourism: Quantitative and Qualitative Approaches, Edward Elgar.
9. Faulkner, H.W., Faulkner, B., Fredline, L., Jago, L. and Cooper, C.P. (2003): Progressing Tourism Research, Channel View Publications.
10. Fennell, D.A. and Malloy, D.C. (2007): Codes of Ethics in Tourism: Practice, Theory, Synthesis, Channel View Publications.
11. Gössling, S. and Hall, C.M. (2006): Tourism and Global Environmental Change: Ecological, Social, Economic and Political.
12. Hall, C.M. (2011): Fieldwork in Tourism: Methods, Issues and Reflections, Routledge.
13. Hall, C.M. and Page, S.J. (2014): The Geography of Tourism and Recreation: Environment, Place and Space. Taylor & Francis.
14. Hall, C.M. and Tucker, H. (2004): Tourism and Postcolonialism: Contested Discourses, Identities and Representations, Routledge.
15. Hudman, L.E. and Jackson, R.H. (2003): Geography of Travel and Tourism, Thomson/Delmar Learning Interrelationships, Routledge.
16. Jansen-Verbeke, M., Priestley, G.K. and Russo, A.P. (2008): Cultural resources for tourism: patterns, processes and policies, Nova Science Publishers.
17. Suresh, K.T. (1994): Tourism Policy of India: An Exploratory Study, Equations, Bangalore
18. Tribe, J. (2009): Philosophical Issues in Tourism. Channel View Publications.
19. Wearing, S. and Neil, J. (2013): Ecotourism, Taylor and Francis
20. Williams, S. (2009): Tourism Geography: A New Synthesis, Taylor & Francis

Physics

(Students need to choose any one course from the following options)

Course I: Space and Stellar Environment

Introduction: Mass, length and time scale in Astrophysics. Apparent and absolute magnitude.

Units and Measurements: Electromagnetic Spectrum - Measuring stellar characteristics (temperature, distance, luminosity, mass, size).

Sky Coordinates and Motions: Earth Rotation - Sky coordinates - seasons - phases of the Moon - the Moon's orbit and eclipses – time keeping (sidereal vs synodic period); Planetary motions - Kepler's Laws.

Radiation Processes in Astrophysics: Concepts of Radiative Transfer – special relativity – Maxwell's equations – Wave equation – retarded potentials – radiation field – Poynting vector – radiation from accelerated charge – bremsstrahlung – Thomson and Compton scattering – synchrotron radiation – thermal and non-thermal distribution of radiating particles – non-thermal synchrotron radiation – self-absorption – synchrotron and Compton cooling – Inverse Compton catastrophe and brightness temperature limit – propagation effects: dispersion, faraday rotation, depolarization – Atomic and molecular spectra – fine structure and hyperfine transition.

Sun as a star

Solar Parameters, Solar Photosphere, Solar Cycle, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology, Solar Nucleosynthesis.

Equations of stellar structure

Fundamental equations – Hydrostatic equilibrium – Mass distribution – Luminosity distribution – Radiation transport - Convective transport – Condition for convection – Adiabatic temperature gradient – Secondary equations

Modeling and evolution

Approach to solutions - Sun - Main-sequence stars – Spectral types – Convective regions - Hertzsprung–Russell diagram – Color-magnitude diagram – Effective temperature and radius - Giants and supergiants - Evolution of single stars – Solar evolution – Massive stars – Gamma-ray bursts – Globular clusters – Open clusters – Variable stars - Scaling laws – Matter density – Pressure – Temperature – Luminosity – Mass dependence – H-R diagram comparison – Homology transformations

Compact stars

White dwarfs – Mass-radius relation – Stability – Sirius B – Chandrasekhar mass limit - Neutron stars – Radius of a neutron star – Equations of state and structure – Evidence for neutron stars – Maximum mass - Black holes – Event horizon (Schwarzschild radius) – Angular momentum – -Static Black Holes (Schwarzschild and Reissner - Nordstrom) - Rotating Black Holes - Kerr Metric (derivation not required) - Event Horizon - Extraction of energy by Penrose process - Kerr-Neumann Metric (no derivation) - No hair

theorem - Cosmic Censorship Hypothesis. Innermost stable orbit – Broad, distorted iron line – Planck length – Particle acceleration – Evaporation – Existence of black holes

The Milky Way: Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way. (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.

Milkyway in different wavelengths: Optical, IR, radio and X-rays.

Interstellar Medium: Density, Contents, different models, extinction.

Galactic Plane Surveys: Log N – Log S Plot.

Telescopes and Detectors: Principle of Optical, Infrared, Radio, X-rays, Gamma-rays, Neutrinos and Cosmic Ray Astronomy; Gravitational Radiation; Detection of Dark Matter and Dark Energy - Astronomy from Space; Imaging – Focal Plane Imagers, PSF and Deconvolution, Interferometry- Photometry, Spectroscopy, Polarimetry, Astrometry; Solar Telescopes; Surveys, Astronomical Databases, Virtual Observatory. Names of most Popular Telescopes in different Wave Bands – TMT, Giant Meter Wave Radio Telescope (GMRT) - Square Killometer Array (SKA), Astrosat.

Galaxies: Hubble's Classification of Galaxies, Galaxy Morphology, Contents and Dimensions – Collisionless Stellar Dynamics – Relaxation Time, Dynamical Friction, Violent Relaxation – Galactic Potential and Orbits – Spiral Density Wave and Lindblad Resonance – Rotation Curves – Tully-Fisher Relation – Central Black Holes and Fundamental Plane Relationship– Mass and Luminosity Function – Press Schechter Formalism – Star Formation History and Chemical evolution – Active Galaxies and Activity Duty Cycle – Galaxies at High Redshift - Evidence of Dark matter. Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo), Gas and Dust in the Galaxy, Spiral Arms.

Cluster of Galaxies: Properties, Classification, Virial Theorem

Suggested readings:

1. BW Carroll & DA Ostlie, An Introduction to Modern Astrophysics, Latest Edition, Addison-Wesley.

2. Frank Shu, The Physical Universe, Latest Edition, University Science Books

3. Martin Harwit, Astrophysical Concepts, Latest Edition, Springer.

4. T. Padmanabhan, Invitation to Astrophysics, Latest Edition, World Scientific Publishing Co.

5. T. Padmanabhan, Theoretical Astrophysics vols 1-3, Latest Edition, Cambridge University Press.

6. Malcolm Longair, High Energy Astrophysics, vols 1-2, Latest Edition, Cambridge University Press.

7. Sparke and Gallaghar, Galaxies in the Universe: An Introduction, Latest Edition, Cambridge University Press.

8. Dina Prialnik: An Introduction to the Theory of Stellar Structure and Evolution, Latest Edition, Cambridge University Press.

Course II: Nanoscience and Technology

Introduction and Synthesis of Nano Materials:

Introduction to nanomaterials, Properties of materials & naomaterials, role of size in nanoparticles, nanowires, quantum wells. Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; Metal nanocrystals by reduction, Sol-gel synthesis. Fabrication of Nanomaterials by Physical Methods: RF plasma, Ion sputtering, Laser ablation, Ball Milling, Molecular beam epitaxy, and physical vapour deposition method. Nanocomposites: An Introduction: Types of Nanocomposites (i.e. metal oxide, ceramic, glass and polymer based); Core-Shell structured nanocomposites.

Properties and Applications of Nano Materials:

Nanostructures: Zero-, One-, Two-and Three- dimensional structure, Size control of metal Nanoparticles and their properties: Optical, Electronic, Magnetic properties; Surface plasmon Resonance, Change of bandgap; Application: catalysis, electronic devices, optical devices, spintronic devices. Giant magnetoresistance, Tunneling magnetoresistance, Colossal magneto resistance, Superparamagnetism and applications.

Characterization of Nanomaterials:

X-ray Diffractometer; Optical spectroscopy: UV-Vis, Photoluminecsence, FTIR, Raman; Microscopy: Scanning Probe microscopy, Electron Microscopy.

Suggested readings:

1. Nanoscale materiauniversels -Liz Marzan and Kamat.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004
3. Processing & properties of structural naonmaterials - Leon L. Shaw (editor)
4. Nanocomposite science and technology – P.M. Ajayan, L.S. Schadler, P.V. Braun, Wiley, New York
5. Novel Nanocrystalline Alloys and Magnetic Nanomaterials- Brian Cantor
6. Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing.

Paramedical and Allied Health Sciences

[A candidate choose any two units from the following

- **Laboratory Practices:** Biosafety Level Criteria (BSL-1-3). Laboratory organization and safe operating procedure (SOP). Handling, transfer and shipment of specimen. Decontamination and disposal. Treatment and disposal technologies for health- care waste. Safety equipment & Safety signs. Handling of biohazards materials. Cleaning and decontamination of glassware and laboratory waste materials. Sterilization techniques. Assignment on laboratory practices.
- **Cell culture Lab:** Introduction to cell culture laboratory- requirements and application. Sterile cell culture technique. Isolation and culturing of primary cells and cell lines- importance. Counting viable cells- staining and use of haemocytometers. Cell attachment (adhesion) and growth. Cell staining techniques. Microscope- types and uses of Light and fluorescence microscope, inverted and upright, phase-contrast. Immunocytochemistry techniques. Centrifugation-principle, type & application. Flowcytometry. Assignment on cell culture technique.
- **Molecular-biology techniques:** DNA, RNA and protein isolation from cell, tissue and other biological samples. Separation of nuclear and sub-cellular fractions. Electrophoresis- Agarose gel electrophoresis, NATIVE and SDS-PAGE. PCR, reverse transcriptase PCR, real-time PCR: principle, application, primer designing, data analysis. Blotting techniques. DNA sequencing & RNA sequencing-methods, application and data analysis. Assignment on molecular biology technique.
- **Immunotechnology:** Isolation and identification of immune cells from healthy and infected organs/individuals. Separation of immune cells: FACS and MACS technique. Immunoprecipitation, agglutination reactions. ELISA, Immunoblotting, immunocytochemistry, immunohistochemistry technique. Co-Immunoprecipitation (Co-IP), Chromatin Immunoprecipitation (ChIP), Immunofluorescence technique. Inflamasome analysis. DTH reaction-principle, procedure and data analysis. Antibody development and antibody isotyping and characterization. Assignment on immunotechnology.
- **Analytical techniques:** Spectroscopy: UV-visible spectroscopy, fluorescence spectroscopy, FTIR, NMR - principle, instrumentation, application. Chromatography: Principle and application of gel filtration, ion-exchange, affinity chromatography. Thin layer, gas chromatography, high pressure liquid chromatography –MS: principle, instrumentation, application and data analysis. Micro plate reader – multimode reader: principle and application. Assignment on analytical technique.
- **Neurosciences:** Localization of different parts of brain in rodent and human origin. Separating different parts of brain. Isolation and identification of different types of neuronal and glial cells – culture, maintenance and functional studies. basic concept of neuroimmunology, identification and properties. Neuroimmune disorders. Cognitive function test. Neuro-Behavioural disorders. Assignment on neurosciences.

Microbial Technology

(Choose any one unit from the following)

Unit I: Cell culture techniques

Introduction to course and lab safety, Brief review of basic lab techniques, Review / Introduction of microscope use: Light and fluorescence microscope, Cell culture: Introduction to sterile cell culture technique. Counting viable cells and subculture into multiwell plates. Cell counting using hemocytometers. Cell attachment (adhesion) and growth. Cell attachment (adhesion) and growth. Cell staining techniques: Culturing of primary cells, preparation of human chromosome, Application of primary cell culture techniques. Isolation of chromosomal DNA, Preparation of cellular extract, isolation of nuclear extract and cytoplasmic extract.

Unit II: Advanced Microbiology

1. Safety manuals of microbiology research laboratory.
2. Laboratory Biosafety Level Criteria (BSL-1-4).
3. Growth curve, culture media, methods of culture.
4. Unculturable microbes and metagenomics.
5. Antibiotic sensitivity, Mechanism of antimicrobial resistance.
6. Virus, bacteriophage, impact of bacteriophage on food fermentation.
7. Fermentation: Submerged and solid-state fermentation, Types of fermenters, Design and operation of Fermenters.
8. Enzyme immobilization.
9. Prebiotics, Probiotics and Functional foods.
10. Bioinformatics: Data Generation and Data Retrieval: Sequence submission tools (BankIt, Sequin); Sequence filenformat (flat file, FASTA, Genbank, Genpept, EMBL, Swiss-Prot); Sequence Alignment, Sequence similarity searching, Methods of Alignment, Local and global alignment, pairwise and multiple sequence, Concept of identity and homology of sequences. Phylogenetic analysis.

Nutrition

Unit 1: Cell culture techniques

Introduction to course and lab safety, Brief review of basic lab techniques, Review / Introduction of microscope use: Light and fluorescence microscope, Cell culture: Introduction to sterile cell culture technique. Counting viable cells and subculture into multiwell plates. Cell counting using hemocytometers. Cell attachment (adhesion) and growth. Cell attachment (adhesion) and growth. Cell staining techniques: Culturing of primary cells, preparation of human chromosome, Application of primary cell culture techniques. Isolation of chromosomal DNA, Preparation of cellular extract, isolation of nuclear extract and cytoplasmic extract.

Unit 2: Microbiology

The world of microbiology and development of microbiology as a scientific discipline, Methods of studying microbes: Introduction to various types of microbes, Growth of bacteria; Control of Microbes; Isolation, identification and characterization of bacteria Prokaryotic cell structure and function.

Unit3: Molecular Biology Techniques

Principles and application of gel Filtration, ion-exchange and Affinity Chromatography, Thin layer and Gas Chromatography-MS

DNA Molecular Technique

Isolation and purification of DNA samples from different cell types and tissues, DNA concentration techniques, restriction digestion and analysis, ligation of DNA to create recombinant molecules and "designer genes."

Southern Blotting

Agarose gel electrophoresis, DNA transfer techniques, isotopic and non-isotopic probe labeling methods, hybridization, x-film exposure, interpretation of results.

Northern Blotting

Blotting of isolated and purified total and/or poly(A+) mRNA from cells and from tissues. Denaturing gel electrophoresis, RNA transfer techniques, isotopic and non-isotopic probe labeling methods, hybridization, x-film exposure, interpretation of results.

Western Blotting

Protein expression study

Polymerase Chain Reaction (PCR)

Fundamentals of PCR, primer design, PCR amplification tools and techniques, hot-start PCR, TA cloning, TOPO cloning, characterization of PCR products, applications of the PCR technique, Long-range PCR and alternative amplification.

DNA Sequencing

Basics and applied methods of DNA sequencing, modern day tools and instruments for sequencing, dideoxy sequencing, 454 sequencing, Illumina, ABI SOLID, applications of sequencing in drug discovery and development, single nucleotide polymorphism (SNP)s identification and characterization techniques, SNPs applications in modern day drug discovery, CNV identification, identification of gross chromosomal deletions. Application of high throughput sequencing in genome wide association study.

Zoology

(Choose any two from the following)

I. Biodiversity Studies:

a. Megadiversity countries, Biodiversity hotspots.
b. Estimating biodiversity, biodiversity indices.
c. IUCN Red List Category; IUCN categories of Protected Areas.
d. Distribution, habitat utilization, threats to survival of Endangered fauna, and conservation strategies.
e. Climate change and its effect on wildlife. Human-animal conflict.
f. Tools and techniques for wildlife census and survey. Technologies for Wildlife Research and Management. Molecular techniques and application of Remote sensing.

II. Ecological Studies:

a. Community ecology
b. Global environmental issues
c. Solid waste recycling
d. Wasteland and watershed management
e. Bioinvasion

III. Ecotoxicology:

a. Environmental pollutions and sustainable environmental management, ecodegradation and conservation, Green movement.
b. Xenobionts, mechanism of action, concept of LC50 and LD50, Drug metabolising enzyme activity study: Cytochrome P450 and Sulfotransferase, Heavy metal toxicity, Pesticide toxicity, Immunotoxicology, Environmental genotoxicity studies (tools and techniques).

IV. Aquaculture and Fishery Science:

a. Taxonomy of fishes.
b. Physiology of fishes.
c. Limnology and oceanography.
d. Fish endocrinology.
e. Fish Genetics and biotechnology
f. Fish pathology and disease management
g. Fish nutrition and bioenergetics
h. Aquaculture management

V. Animal Physiology:

a. Blood, Circulation and Respiration
b. Cardiovascular System
c. Stress physiology

d. Thermoregulation

VI. Genetics:

a. Basic Principles of inheritance, molecular basis of heredity, sex determination and sex-linked characteristics, cytoplasmic inheritance, linkage.
b. Bacterial recombination and mapping of genes in eukaryotes.
c. Sex determination and dosage compensation in Drosophila and human.
d. Population genetics.
e. Genetics of Cancer, Gene Therapy.

VII. Bioinformatics:

a. Biological database management systems
b. Data archiving system
c. Application of Bioinformatics

VIII. Parasitology and Immunology:

a. General concept about vector- mode of transmission.
b. Biology, importance and control of some vectors.
c. Life cycle, pathogenecity and control of some vector borne parasite.
d. Zoonosis and Myiasis.
e. Molecular Diagnosis & Clinical Parasitology.
f. Fundamental techniques used in molecular diagnosis of endoparasites.
g. Immunoassay or serological techniques.
h. Innate and Adaptive Immunity
i. Antigens, Immunoglobulins, Cytokines
j. Major Histocompatibility Complex, Complement System
k. Hypersensitivity, Immunology of diseases, Vaccines

IX. Haematology:

a. Haemopoetic tissues: Structure & function.
b. Blood cells: Structure & function.
c. Red cell abnormalities (Anemia).
d. White cells and their disorders (Leukemia).
e. Physiology of coagulation & Haemostasis.

X. Histochemistry:

a. Microtechnique
b. Fixation
c. Dyes

d. Histological staining

e. Enzyme histochemistry

f. Immunohistochemistry

XI. Neuroendocrinology:

a. Basic concept of neural system

b. Development and differentiation of neural circuit in vertebrates

c. Neuroendocrine glands in animal

d. Neuro-immuno endocrine pathways

e. Neural/ endocrine disorders

XII. Biochemistry and Cell Biology:

a. Proteins, lipids and carbohydrates.
b. Glycolysis and Kreb's cycle, Pentose phosphate pathway, Gluconiogenesis.
c. Formation of urea,denovo synthesis of fatty acids, Oxidation of fatty acids. Electron transport chain.
d. Mechanism of enzyme catalysis, Inhibition, Allosterism.
e. Hormones and their actions, vitamins.
f. Structure of cell, cellular organelles and their structure and function, Cell cycle & its regulation , cell division, chromosomes and chromatin structure.
g. Biomembrane Structure.
h. Transmembrane Transport, Signal Transduction.

XIII. Molecular Biology and Molecular Techniques:

a. Central Dogma: DNA Replication, Transcription Process, Protein Synthesis
b. DNA damage and Repair
c. Regulation of Gene Expression in Prokaryotes and Eukaryotes
d. Recombinant DNA technology, Cloning Vectors.
e. PCR, DNA finger printing, Western Blotting Hybridization, Southern Blotting Hybridization, Northern Blotting Hybridization.
f. Bioremediation, Phytoremediation, Cryopreservation.
g. Basic Principles of Electrophoresis, Agarose Gel Electrophoresis, SDS-PAGE,
h. Cell fractionation, Ultracentrifugation, Chromatography, Flow Cytometry, FISH, FTIR.
i. Biosafety management.

Botany

(Unit 1 is compulsory and any one from unit 2)

Unit 1 **Full Marks-25**

a. Microscopy: Principles and construction of light microscope, phase contrast microscope, Confocal microscope, fluorescent microscope, scanning and transmission electron microscope.
b. Principles and applications of gel filtration, Ion exchange, Affinity, thin layer and Gas Chromatography-MS.
c. Basic principles of electrophoresis, SDS-PAGE, Cell fractionation, Ultracentrifugation.
d. Molecular analysis using UV/visible, fluorescence, Spectroscopy, Spectrometry.
e. Autoradiography and image cytometry, flow cytometry, chromosome banding and karyotyping.
f. Isolation and purification of DNA, RNA and plasmid.
g. Generation of radiolabeled probe, blotting techniques.
h. DNA Sequencing methods; PCR, RFLP, AFLP, RAPD and ELISA, RIA, FISH and GISH.
i. SNP analysis; DNA Bar-coding, Karyotype (symmetric & asymmetric including bimodal), finger printing
j. cp DNA (rbcl); mt DNA; n DNA (ITS).
k. Introduction to course and lab safety, Cell culture: Introduction to sterile cell culture technique. Counting viable cells and subculture into multiwell plates. Cell counting using hemocytometers. Cell attachment (adhesion) and growth. Cell attachment (adhesion) and growth.
l. Gene transfer techniques: Biolistic method/ Gene gun, Ti plasmid structure.
m. Plant cell culture: Callus culture, Micropropagation (Principle, outline methods and application).
n. Sequence databases: Nucleic acid sequence databases: GenBank; Protein sequence databases: Uniprot-KB: SWISS-PROT; Structure Databases: PDB.
o. Introduction: Aim and branches of Bioinformatics, Application of Bioinformatics, Bioinformatics Resources: NCBI, EBI.
p. Basic concepts of sequence alignment: Measurement of sequence similarity; Similarity and homology. Pairwise sequence alignment; Homology Modeling.
q. Crude drug analysis

Suggested readings:

1. Rastogi, S. C., Rastogi, P., & Mendiratta, N. (2008). Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery 3Rd Ed. PHI Learning Pvt. Ltd..
2. Attwood, T. K., & Parry-Smith, D. J. (2003). Introduction to bioinformatics.
3. Tsai, C. S. (2003). An introduction to computational biochemistry. John Wiley & Sons.
4. Gibas, C., Jambeck, P., & Fenton, J. M. (2001). Developing bioinformatics computer skills. " O'Reilly Media, Inc.".
5. Somer Jr, F. L. (2004). Molecular Modelling for Beginners (Alan Hinchliffe).6. Tools in Biochemistry David Cooper

6. Parish, J. H. (1987). Methods of protein and nucleic acid research volume 3 by LA Osterman (translated from the Russian). pp 505. Springer-Verlag, Berlin. 1986. DM 248 ISBN 3-540-16855-9.
7. Rickwood, D. (1992). Preparative centrifugation: A practical approach (pp. 43-46). Oxford, UK: IRL Press.
8. Mu, P., & Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.
9. Sadasivam, S. & Manickam, A. (2008). Biochemical methods, New Age International, 2008.
10. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: a laboratory manual (No. Ed. 2). Cold spring harbor laboratory press.

Unit II **Full Marks-25**

Advance plant systematics

a. Biosystematics and its categories: APG- IV classification; Plant identification using different keys.

b. Taxonomic study of unknown plants of different flora, preparation of 'Keys' and identification of plants by use of keys and matching.

c. Roles of taxonomic literature (Index Kewensis, Dictionaries, Manuals, Bibliographies, Flora etc.) in modern research.

d. Numerical analysis of different phytochemical data to study interspecific variation and construction of dendrograms.

e. Herbarium technique, Digital herbarium.

f. Taxonomic evidences from Cytology, Phytochemistry, Molecular Taxonomy, Anatomy, Embryology & Palynology; Computer-aided Taxonomy

g. Methods of conservation of bioresources.

h. Taxonomy and conservation: Needs, politics, Economics, issues, plant diversity; Biotechnology and biodiversity conservation, In-situ and ex-situ conservation; Climate change and biodiversity; Biodiversity and Forest Acts; Environment Impact Assesment; Role of Botanical Gardens in plant conservation; Concept of lead Botanical Gardens and Biodiversity Parks; National Programmes on plant conservation.

Reference books:

1. Singh Gurucharan (2010) Plant systematic: An Integrated approach. Science Publisher. USA.
2. Judd, W.S., Campbell, C.S., Kollogg, E.A., Stevens, P.F. and Donoghue M.J. (2008) Plant systematic: Phylogenetic approach. Sinauer Associates, Inc.
3. Futuyma D.J. (2009) Evolution. Sinauer Associates, Inc. Publishers, Sunderland.
4. Groom, M.J., Meffe, G.K. and Carroll, C.R.(2006) Principles of conservation biology. Sinauer Associates, Inc.
5. Etelka leadlay and Stephen jury (2006) Taxonomy and plant conservation. Cambridge
6. University Press. UK.

7. David Briggs (2009). Plant microevolution and conservation in human influenced ecosystems.Cambridge University Press. UK.

Palynology and plant reproductive biology

a. Polarity, symmetry and shape classes of pollen grains, NPC classification, Sporoderm stratification, Exine ornamentation, LO analysis
b. Sources, chemistry and function of sporopollenin
c. Pollen wall proteins: nature, origin & function, marker proteins
d. Aeroallergens: mechanism of Allerginicity, pollen calendar, important and wellcharacterized pollen/spore allergens.
e. Melissopalynology: Physical & chemical characteristics of honey, Types of honey, assessment of honey quality, adulteration of honey, Geographical origin of honey.
f. Floral Morphology and Sexuality
g. Technique of Pollen Biology: Pollen Production, Pollen Fertility, Viability test and Pollen Vigour.
h. Pistil Biology: Stigma Receptivity, Ovule Receptivity.
i. Pollination Ecology: Floral Attractants and Rewards, Floral Visitors and Pollinators, Pollination Efficiency, Pollination Limitation, Pollen Travel and Gene Flow.
j. Pollen biotechnology: Use of pollen for genetic transformation, induction of haploids (pollen embryos) from pollen grains and their utilization, production of hybrid seeds using CMS, GMS, self-incompatibility and r-DNA technology.

Reference books:

1. Bhattacharya, K.N, Majumdar, M.R. & Bhattacharya, S.G. (2011) A Textbook of Palynology, Central Book Agency.
2. Shivanna, K. R., & Rangaswamy, N. S. (2012) Pollen biology: a laboratory manual. Springer Science & Business Media.
3. Shivanna, K. R., & Tandon, R. (2014) Reproductive ecology of flowering plants: a manual (pp. 107-123). New Delhi: Springer India.
4. Dafni, A. (1992) Pollination ecology: a practical approach. Oxford University Press.
5. Shivanna, K. R. (2019) Pollen biology and biotechnology. CRC Press.
6. Erdtman, G. (1986) Pollen morphology and plant taxonomy: angiosperms (Vol. 1). Brill Archive.
7. Kearns, C. A., & Inouye, D. W. (1993) Techniques for pollination biologists. University press of Colorado.

Environmental Science

a. Environmental Science: General Perspectives; Man and Environment; Earth's carrying capacity; Sustainable Development and Environmental Management. Environmental Components-Atmosphere, Hydrosphere, Lithosphere and Biosphere; Land resources: Land use pattern of India, Causes and consequences of Land degradation; Salination and water logging; Control of Land

degradation; Deforestation, Environmental consequences of Dams and mining; Wetlands and their conservation.

b. Concept of Ecosystem: Structure, Components of ecosystem, trophic levels, ecological pyramids; Functional aspects food Chains, Food webs, Ecological energetic: Energy flow and Law of thermodynamics, Ecological efficiency Productivity of Ecosystems, Homeostasis. Types of Ecosystems- Grassland, Forest, desert, fresh water and Marine; Biodiversity and Wildlife: threats to Biodiversity and conservation strategies (In-situ, Ex-Situ); Bioprospecting, Biopiracy and Bio safety. India as a mega diversity Nation-Hot spots of biodiversity and biosphere reserves. Wild life conservation and Management.
c. Types of resources. Energy Resources- Renewable and Non-renewable energy resources: Fossil fuels, Nuclear Energy, Hydropower, Geothermal, Tidal Energy, Wind Energy and Solar Energy. Energy from Biomass-Biogas, Petro-plants and Biofuels; Solid waste management: Sources and types of solid wastes, Hazardous waste disposal methods, RRR – Reduce, Recycle, Reuse Concept; Sources, types and management of E-Waste.
d. Environmental Pollution: Sources, types and effects of Air, Water, Soil and Noise Pollution and their control measures; Pollution control and management in Thermal Power and Nuclear Power Plants
e. Global Environmental Problems: Causes, Consequences and Mitigation measures of Global Warming; Ozone layer depletion, greenhouse effect and acid rains; Climate change, Disasters – Types; Effects of Cyclones, Earthquakes and droughts; Environmental Protection Act, Wild Life Protection Act, Air & Water pollution prevention and control acts.
f. Environmental Biotechnology: Use of DNA probes for low-level detection of living matter in environmental samples, DHA-based taxonomy in the assessment of biodiversity; Cloning of useful gene products, related to microbial degradation of waste products; Use of engineered microbes in leaching of metals from ores, detoxification of industrial wastes, production of ethanol; Potential use of biotechnology in problems of soil reclamation and biological nitrogen fixation.

Suggested readings:

1. Odum, E. P., & Barrett, G. W. (1971). Fundamentals of ecology (Vol. 3, p. 5). Philadelphia: Saunders.
2. Sharma, B. K., & Kaur, H. (2000). Environmental Chemistry; Krishna Prakashan Media (P) Ltd. Meerut, UP Pp. 3. Energy Resources, G.D.Rai, Khanna Publishers.
3. Goel, P. K. (2006). Water pollution: causes, effects and control. New Age International.
4. George, T., Hilary, T., & Samuel, A. V. (1993). Integrated solid waste management: Engineering principles and management issues. Thermal conversion Technol, 629-30.
5. Calvert, S., & Englund, H. M. (1984). Handbook of air pollution technology.
6. Masters, G. M. (1997). Introduction to environmental science and engineering. Upper Saddle River, NJ: Prentice-Hall.

Modern genetics and molecular biology

a. The dynamism and ultrastructure of the nuclear components; nuclear envelope, molecular traffic between nucleus and cytoplasm; nucleolus, chromatin.
b. Cell cycle and cell signalling.
c. Cancer Biology.
d. Ribosomal RNA genes, transcription and processing of rRNA, ribosome assembly
e. Recombinant DNA technology and its application in Agriculture.
f. Chromosome behaviour in differentiation; nuclear DNA and plant evolution.
g. Androgenesis and dihaploids: in vitro production of haploids and dihaploids, significance and uses of haploidy.
h. Molecular plant breeding.
i. Techniques of tissue culture, protoplast fusion technology, somatic hybridization and application.
j. Somaclonal variation: basis of somaclonal variation, scheme for obtaining somaclonal variation, application.
k. Transgenic technology
l. Recent advances in plant biotechnology with special references to CRISPR/Cas9 technology.
m. In Situ and ex situ conservation of germplasm

Suggested readings:

1. Agarwal, S.K. (2007) Bioinformatics. APH Publishing Corporation, New Delhi.
2. Glick, B.R. and Pasternak, J.J. (1994) Molecular Biotechnology: Principles and Application of r-RNA Press, Washington.
3. Gupta, P.K. (2006) Cell and Molecular Biology, Third edition. Rastogi Publications, Meerut.
4. Russell, P. (2010) Genetics- A Molecular Approach, Third edition. Pearson Benjamin
5. Cummings, San Francisco.
6. Singh, B.D. (2009) Biotechnology: Expanding Horizons, Kalyani Publishers.
7. Snustad D.P. & Simmons M.J. (2006) Genetics. 8th Ed. John Wiley & Sons.
8. Strickberger M.W. (2005) Genetics. 3rd Ed. Prentice Hall, New Delhi, India
9. Karp G. (2004) Cell and Molecular Biology: Concepts and Experiments. John Wiley.
10. Klug WS & Cummings MR 2003. Concepts of Genetics. Scot, Foreman &Co.
11. Lewin B. (2008) IX Genes. John Wiley & Sons
12. Lodish H, Berk A &Zipursky SL.(2004) Molecular Cell Biology.5th Ed. WH Freeman.
13. Bruce A.(2004). Essential Cell Biology. Garland.

Agronomuy

a. Advances of crop growth and productivity.
b. Advances in weed management
c. Irrigation management.
d. Stress crop production
e. Principles and practices of soil fertility and nutrient management

f. Research Techniques in Agronomy
g. Integrated farming system
h. Crop production and system modelling

Suggested readings:

1. Kropff, M. J., and Van Laar, H. H. (1993). Modelling crop-weed interactions. Int. Rice Res. Inst.
2. Chopra, V.L. and Paroda, R.S. (1984). Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants. Oxford & IBH.
3. Evans, L. T. (1996). Crop Evolution, Adaptation and yield. Cambridge Univ. Press.
4. Narwal S.S , Politycka B. and Goswami, C.L. 2007. Plant Physiology: Research Methods. Scientific Publishers
5. Panda, S. C. (2009). Principles and practices of water management. Agribios, India.
6. Gupta, O. P. (1993). Weed management: principles and practices. Agro Botanical Publishers.
7. Gupta, O. P. (1993). Weed management: principles and practices. Agro Botanical Publishers.
8. Baker, F. W. G. (1989). Drought resistance in cereals.

Advance Breeding and Biotechnology of Crop Plants

a. Advanced plant breeding systems.
b. Advances in quantitative genetics
c. Genomics in crop improvement.
d. Molecular and chromosomal manipulations in crop improvement
e. Breeding for biotic and abiotic stress resistance.
f. Breeding designer crops
g. In Situ and ex situ conservation of germplasm
h. Crop-evolution
i. Androgenesis and dihaploids: in vitro production of haploids and dihaploids, significance and uses of haploidy.
j. Techniques of tissue culture, protoplast fusion technology, somatic hybridization and application.
k. Somaclonal variation: basis of somaclonal variation, scheme for obtaining somaclonal variation, application.
l. Recent advances in plant biotechnology with special references to CRISPR/Cas9 technology.
m. Transgenic technology

Suggested readings:

1. Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ.
2. Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual.3rd Ed. Cold Spring Harbor Lab. Press.
3. Singh B.D. 2009. Biotechnology, Expanding Horizons. Kalyani.
4. Chopra VL & Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH.
5. Blum A. 1988. Plant Breeding for Stress Environments. CRC Press.

6. Christiansen MN & Lewis CF. 1982. Breeding Plants for Less Favourable Environments. Wiley International.
7. Maxwell F.G. & Jennings P. R. 1980. Breeding Plants Resistant to Insects. John Wiley & Sons.
8. Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual.3rd Ed. Cold Spring Harbor Lab. Press.

Plant Protection

a. Molecular approaches in entomological research
b. Advanced insecticide toxicology
c. Advanced host plant resistance
d. Current topics in nematode disease development and host resistance
e. Advances in nematode management
f. Advanced mycology
g. Advanced virology
h. Advanced bacteriology
i. Molecular basis of host-pathogen interaction
j. Advanced integrated pest management
k. Plant biosecurity and biosafety

Suggested readings:

1. Barbosa P. and Letourneau D.K. (1988). Novel Aspects of Insect-Plant Interactions. Wiley, London.
2. Elizabeth B.A. and Chapman R.F. (1994). Host-Plant Selection by Phytophagous Insects. Chapman & Hall, New York.
3. Burges H.D. and Hussey N.W. (1971). Microbial Control of Insects and Mites. Academic Press, London.
4. Panda N. (1979). Principles of Host Plant Resistance to Insects. Allenheld, Osum & Co., New York.
5. Singh B.D. (2008). Biotechnology (Expanding Horizons). Kalyani Publ., New Delhi.
6. Dhaliwal G.S. Singh R. and Chhillar B.S. (2006). Essentials of Agricultural Entomology. Kalyani Publ., New Delhi.
7. Barker K.R., Pederson G.A. and Windham G.L. (1998). Plant and Nematode Interactions. CABI, Wallingford.
8. Fenoll C, Grundler F.M.W. and S.A. (1997). Cellular and Molecular aspects of Plant-Nematode Relationships. Kluwer Academic Press
9. Ainsworth G.C., Sparrow F.K. and Susman H.S. 1973. The Fungi – An Advanced Treatise. Vol. IV (A & B). Academic Press, New York.
10. Alexopoulos C.J., Mims C.W. and Blackwell M. (2000). Introductory Mycology. 5th Ed. John Wiley & Sons, New York
11. Gibbs A. and Harrison B. (1976). Plant Virology - The Principles. Edward Arnold, London.
12. Jayaraman J. and Verma J.P. (2002). Fundamentals of Plant Bacteriology. Kalyani Publ., Ludhiana

Modern Microbiology

a. Aseptic techniques: Sterilization and disinfection, Isolation and pure culture techniques, and staining; Sample selection, sample collection sample transport; and preservation techniques; Antibiotic susceptibility techniques.
b. Prebiotics, Probiotics and Functional foods.
c. Soil Enzymes : origin and range of enzymes in soil, methods of measurement and extraction of soil enzymes, interactions between agrochemical and soil enzymes. Recent advances in biological Nitrogen fixation microbial biofertilisers.
d. Epidemiology of plant diseases, Biological control of soil borne plant pathogens; New Directions and Importance of Microbial Ecology
e. Antimicrobial responses: Effects of different phytochemicals and antibiotics on microorganisms; Cellular defines strategy of microorganisms against phytochemicals; Recent trends on the use of phytochemicals as antimicrobial and antioxidant agents.
f. Extremophiles: Introduction, Diversity, Habitat, Physiology and applications of Thermophilic, Acidophilic, Alkaliphilic, Barophilic, Halophilic, Psychrophilic, microorganism and microorganism resistant to radiations.
g. Recent advances in Microbiological waste treatment methods -Activated Sludge Process, Anaerobic sludge digestion, Root zone technology, Microbial biosorption technology, Mass scale production of Effective Microorganisms (EM) for waste treatment, Economics of waste treatment

Suggested readings:

1. Bergey, D. H., Hendricks, D., Holt, J. G., & Sneath, P. H. (1984). Bergey's Manual of systematic bacteriology. Vol. 2. Williams & Wilkins. S. Sridhar
2. Dart, R. (Ed.). (2012). Microbiological aspects of pollution control (Vol. 6). Elsevier.
3. Callely, A. G., Forster, C. F., & Stafford, D. A. (1976). Treatment of industrial effluents. John Wiley & Sons.
4. Mitchell, R. (1972). Water pollution microbiology.
5. Birkett, J., & Lester, J. (2018). Microbiology and chemistry for environmental scientists and engineers. CRC Press.
6. Rao, M. N. (2018). Waste water treatment. Oxford and IBH Publishing.
7. Burns, R. G. (1978). Soil enzymes.
8. Postgate, J. (2012). The chemistry and biochemistry of nitrogen fixation. Springer Science & Business Media.

English

(Any two units from the following)

Unit- I: New Criticism & Russian Formalism

a. John Crowe Ransom: New Criticism
b. Cleanth Brooks: The Well Wrought Urn: Studies in the Structure of Poetry
c. William Empson: Seven Types of Ambiguities
d. Roman Jackobson: “Metaphor & Metonymy”
e. Mikhail Bakhtin: “Forms of Time and the Chronotope in the Novel” from The Dialogic Imagination
f. Viktor Shklovsky: “Art as Technique”

Unit -II: Structuralism & Marxism

a. Ferdinand de Saussure: Course in General Linguistics
b. Claude Levi Strauss: Myth & Meaning
c. Jonathan Culler: Structuralist Poetics
d. Terry Eagleton: Marxism & Literary Criticism
e. Theodore Adorno and Max Horkhiemer: “The Cultural Industry”
f. Louis Althusser: On Ideology

Unit-III: Post-structuralism

a. Jacques Derrida: “Writing and Difference”
b. Michel Faucault: “What is an Author”
c. Ronald Barthes: “From Work to Text”
d. Gilles Deleuze & Felix Guattari: “What is Minor Literature”
e. Jean Baudrillard: Simulacra and Simulation
f. Jacques Lacan: The Four Fundamental Concepts of Psychoanalysis

Unit- IV: New Historicism & Cultural Materialism

a. Stephen Greenblat: Renaissance Self-fashioning
b. Jonathan Dollimore & Allan Sinfield: Political Shakespeare: Essays in Cultural Materialism
c. Raymond Williams: Culture and Society
d. Raymond Williams: Culture and Materialism

Unit- V: Feminism & Post-colonialism

a. Judith Butler: Gender Trouble
b. Chandra Talpade Mohanty: Under Western Eyes: Feminist Scholarship and Colonial Discourses
c. Toril Moi: Sexual/Textual Politics
d. Edward Said: Orientalism
e. Frantz Fanon: Wretched of the Earth
f. Ngugi Wa Thiongo: Decolonizing the Mind
g. Homi K Bhabha: The Location of Culture

Unit- VI: Postmodernism & Eco--criticism

a. Gilles Deleuze & Felix Guattari: The Rhizome: A Thousand Plateaus
b. Jean Francois Leotard: The Postmodern Condition: A Report on Knowledge
c. Donna J Haraway: "A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s"
d. Fredric Jameson: Postmodernism or the Cultural Logic of Late Capitalism (Selected reading)
e. Karen J. Warren: The Promise and Power of Ecofeminism
f. Isabel Sobrial Campos: Ecopoetics and the Global Landscape: Critical Essays
g. William Rueckert: Literature and Ecology: An Experiment in Ecocriticism

Unit- VII: Indigeneity, Ethnicity & Subalternity

a. Gayatri Chakravorty Spivak: "Can the Subaltern Speak?"
b. Ranajit Guha: A Subaltern Studies Reader
c. G. N. Devy & Geoffrey V. Davis: Indigeneity and Nation
d. Joseph Skerrett: Literature, Race and Ethnicity: Contesting American Identities
e. Verrier Elwin: The Tribal World of Verrier Elwin
f. Vladimir Propp: Morphology of the Folktales
g. Joseph Campbell: The Hero with a Thousand Faces