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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Science & IT	Science	**Physics**	**PHY019902**

Unit-wise Content distribution

Unit	Contents
Unit-I	**Material characterization Techniques** 1. Introduction: Physical and chemical properties . Necessity of characterization. (a) Macroscopic properties: Optical. Electrical, dielectric, magnetic, mechanical (b) Microscopic properties – chemical structure, composition, surface characterization. 2. Probing bulk and nano-structure – XRD, TEM, HRTEM, Neutron scattering. 3. Surface structure and topography – SEM, STM, LEED, AFM 4. Microstructure – UVVIS, Raman, FTIR, Optical microscopy, small angle scattering 5. Phase changes, crystalline and amorphous fractions – DSC 6. Thermo-gravimetric methods – TGA, DTA 7. Mechanical properties: Elastic properties, strength measurements in bulk and thin films, nano-indentation, Physics of fracture – Griffith's theory of brittle fracture, ductile fracture, length scale issues and size effects
Unit-II	**Production of low temperatures and low-temperature properties of materials.** i) **Production and measurement of low temperature**: The range of low temperature; Need of vacuum; Different pumps to produce vacuum of required order (Rotary pump, Diffusion pump etc.); Properties of liquid oxygen, liquid nitrogen and liquid helium; Construction of Thermostat and Cryostat. Measurement of low temperature using different techniques. ii) **Physical properties of solid at low temperature:** **a) Spectroscopic properties:** Infra red and visible spectra, Zeeman spectra; Formation of laser and its principles; Use of laser in Spectroscopy; Laser cooling. **b) Transport properties:** Dielectric constant and its measurement; Electrical properties of solid; Low temperature specific heat of solid. **c) Magnetic Properties:** Low temperature Magnetic susceptibilities; Electron paramagnetic resonance, Nuclear magnetic resonance etc. **d) Hyperfine properties:** Nuclear magnetic properties; Electric quadrupolar effect at nuclear site; Mossbauer effect and other hyperfine properties of the solids
Unit-III	**3 Physics of Semiconductor Structures and Quantum Well Devices** 1. Heterostructure Growth: 2. (i) Molecular Beam Epitaxy, (ii) Metal organic Vapor Deposition, (iii) Chemical Beam Epitaxy, (iv) Other methods. 3. Lower Dimensional Structures: 2D structure, 1D structure, 0D structure. 4. Band Offset: 5. (i) Types of heterostructures (ii) Electron Affinity rule (iii) Common Anion rule (iv) Theoretical method of calculation of Band offset (v) Experimental methods. 6. Electron States: 7. (i) Effective mass approximation (ii) Energy levels of electrons in quantum well, Super lattice, Single heterojunction, Quantum wire and dot. (iii) Energy levels of holes 8. Optical Interaction Phenomena: 9. Interaction in quantum wells (ii) Excitons (iii) Absorption - 10. Transport Properties: 11. (i) Solution of the transport equation for 2 DEG, (ii) Mobility, (iii) High –field velocity, (iv) Ballistic Transport

	12. Structure and Principle of Operation of (i) High Electron Mobility Transistor, (ii) Resonant Tunneling Diode (iii) Quantum Well Laser (iv) Quantum Well Detector, Modulator and Switch (v) Optical Bistable Devices.
Unit-IV	**Advanced X-ray crystallography for Ph D course work**
	i) Symmetry in crystals, space groups and cell transformation
	ii) Principle of X-ray powder diffraction, Measurement of X-ray powder diffraction patterns, Powder diffractometers, Principles of goniometer design in powder diffractometry, Monochromatic radiation, Bragg-Brentano geometry, Debye-Scherrer geometry.
	iii) Sample preparation for X-ray powder diffractometry, Sample mounting, Particle size requirement, Sample thickness and uniformity, Effects of sample preparation on powder diffraction data, Data acquisition, Quality of experimental data.
	iv) Preliminary data processing and phase analysis, Use of crystallographic data base, Phase identification and quantitative analysis, Different methods of quantitative phase analysis.
	v) Indexing powder diffraction pattern, Basic relations, The indexing problems, Geometrical ambiguities, Different indexing programs, Figures of merit, Precise lattice parameters and least-squares method.
	vi) The Rietveld method, Rietveld method basics, Background contribution, Peak-shape function, profile parameters, Quality of Rietveld refinemet, Different R-factors.
	vii) Crystallite size and lattice strain determination from line broadening, The Scherrer equation, The Fourier method of Warren and Averbach, Method of integral breadths.
	viii) Radial distribution studies of non-crystalline materials, Experimental requirements, Correction and Scaling of experimental intensities to absolute (electron) units, Practical examples.
	ix) EXAFS, EDX, XFS, XPS.
	x) Diffraction of X-rays by liquids and liquid crystals, Information obtained from X-ray studies of liquid crystalline materials.
	xi) Protein crystallography: Basics of protein structure, Secondary structure elements, α-helix and β-sheet, Tertiary structure; Phasing methods: Isomorphous replacement, Molecular replacement, Multiple anomalous dispersion; Non-crystallographic symmetry and density modifications.
Unit-V	**Physical Cosmology** **i) The expansion of the Universe:** **Cosmological principles:** Cosmological principles, the Robaertson Walker metric, the redshifts, Hubble's law, Distances at small redshift. **Dynamics of expansion:** Basics of Friedman – Roberson Walker cosmology, Cosmological parameters, Dark matters, Age of the Universe, Particle horizon, Event horizon, Models with ⃞ term, Luminosity distance, Angular diameter distance, Source counts.
	Distances at large redshifts: Accelerated expansion, Discovery of accelerated expansion, Discovery of early deceleration, Equation of state w parameter, The cosmological constant problems.
	Intergalactic absorption: Optical depth, Resonant absorption, 21 cm absorption, Lyman α absorption, Gunn Peterson trough. **ii) Relics of the big bang:** Expectations and discovery of the microwave background radiation, Black body radiation, RayleighJeans formula, Balloon and Rockets experiments, COBE, FIRAS, WMAP experiments and its implication, Power spectrum of the CMB. **iii) The early Universe:** **Thermal history:** FermiDirac, BoseEinstein distributions, Time vs. temperature, Effective number of species, Neutrino decoupling, Heating by electronpositron annihilation, Neutrino masses and chemical potentials.

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Cosmological nucleosynthesis: Neutronproton conversion, Equilibrium nuclear abundances, Deuterium bottleneck Helium abundance, Deuterium abundance $He3$ abundance, Lithium abundance, Ω $h2$.

iv) Formation of the large scale structure:

Linear perturbations after recombination: Hydrodynamic and field equation, Factorization of perturbations, Effect of vacuum energy, Power spectral function P(k), correlation function, Direct measurement of P(k), Rms fluctuation σR, measurements of P(k), Baryon acoustic oscillations, Cosmic variance in measuring P(k).

Nonlinear growth: Spherically symmetric collapse, Calculation of σR, Press Schechter mass function

Textbooks/References

1. G. B. Arfken and H.J. Weber, Mathematical Methods for Physicists, 5th edition, Academic Press (2001).
2. E. Kreyszig, Advanced Engineering Mathematics, 8 th edition, John Wiley & Sons Inc. (1999).
3. Mathematical Methods in the Physical Sciences, 3rd edition, Mary L. Boas, WileyIndia (2011)
4. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, 3nd edition, Addison & Wesley (2000).
5. W. Greiner, Classical Mechanics, Springer-Verlag (2003).
6. W. Greiner, Classical Mechanics – Point particles and Relativity, Springer (1989).
7. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill (1976).
8. J.L. Powell and B. Crasemann, Quantum Mechanics, Narosa Publishing House (1993).
9. J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (1999).
10. Quantum Mechanics, Aruldhas, Prentice Hall of India (2006).
11. D. J. Griffiths, Introduction to Electrodynamics, Prentice Hall of India, 3nd edition (1999).
12. J.R. Reitz., F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory, 4 th edition, Pearson (2010)
13. M.W. Zeemansky and R.H. Dittman, Heat and Thermodynamics, 8th edition, McGraw Hill (2011).
14. K. Haung, Statistical Mechanics, 2nd edition, Wiley India (2010).
15. F.W. Sears and G.L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd edition, Narosa Publishing House (1998).

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Science & IT	Science	Chemistry	CHEM019902

Unit-wise Content distribution

Unit	Contents
Unit-I	**Chemistry Of Pollution: Soil, Air, Water** Introduction to environmental pollution; Concept, nomenclature and segments; Composition of atmosphere; Pollution of atmosphere; Types of air pollutants; Oxides of Carbon, Sulfur, Nitrogen and Hydrocarbons etc; Effect on health and environment; Green house effect, Acid Rain and Photochemical smog. Effect of Ozone on Health & Environment; Chlorofluorocarbons; Effect of Gasoline on air pollution; Presence of lead in the atmosphere; Classification of Soil Pollutants; Source and Classification of Solid Waste; Disposal of Solid Waste on land and Sea; Techniques of recycling of Solid Waste. Treatment methods for water and waste:
Unit-II	**Instrumentation and analytical techniques** Introduction of analytical and instrumental methods, techniques of analysis concept and principle of UV, IR, Mass, Atomic absorption spectroscopy and 1D ,2D NMR: SAR, Chromatography Gel filtration HPLS,GLC,MALDI,GC.
Unit-III	**Pharmacokinetics And Antibiotics:** Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drugs. Synthetic chemistry, natural products (Internodes) uses and application of heterocyclic compound, synthetic and natural drug. of penicillin G, penicillin V, chloramphenicol, tetracycline and streptomycin
Unit-IV	**Bio-Inorganic Chemistry:** Meta! ions in biological systems (Macro & Micro elements); Importance of Na, K, Mg, Ca in Biological Processes; Photosynthesis: Light Reaction (Cyclic & Non-Cyclic Photo-hosphorylation) & Dark Reaction (C3 Cycle). Nitrogen Fixation: Mechanism of reduction of N2;
Unit-V	**Photochemistry:** Types of Photochemical reactions; Laws of Absorption (Grothuss-Draper law & Einstein's law);Quantum yield; Primary & Secondary Photochemical processes; Joblonski Diagram: Fluorescence, Phosphorescence, Delayed Fluorescence, Inter-System Crossing; Internal Conversion- Vibrational Cascade and Chemiluminescenc

Textbooks/References:

1. "Advanced Physical Chemistry" by Gurudeep Raj; Goel Publishing House, Meerut (24th Edition, 1999).
2. "Physical Chemistry' by Peter Atkins and J.D.Paula; ELBS, Low Price Edition (7th, Edition, 2002).
3. "Chemical Kinetics" by K.J.Laidler; Tata Mc Graw- Hill Publishing Company Ltd, New Delhi (2nd Edition, 1984).
4. "Principles of Physical Chemistry by Maron and Prutton; Oxford and IBH Publishing Co Pvt Ltd (New Delhi) and Calcutta (4th Edition, 1966).

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Science & IT	Science	Mathematics	MATH019902

Unit-wise Content distribution

Unit	Contents
Unit-I	**Error in Numerical Calculations**: Numbers and their accuracy, errors and their Analysis, General error formula, Error in a series Approximation.Two Point boundary value Problems: Linear ordinary differential equations, Non Linear ordinary differential equations, Non-uniform grid methods for the Seconds order Boundary value problems.Numeric Solution of Integral Equations: Integral equation, Finite difference methods, methods of degenerate Kernets, Method of Invariant Impeding, Method using Generalized Quadrature, Evaluation of singular integrals
Unit-II	**The lebsegue integral** :Riemann integral - The lebsegue integral of bounded function over a set of finite measure- The integral of a non-negative function-The general lebsgue integral-Convergence in measure.Introduction: - Outer measure - sets & Lebsegue measure - A non measurable set - Measurable functions-Littlewood's three principals.
Unit-III	**Measurable spaces**: Ring, Alzebras, Monotone classes, measurable space. Measurable functions: Labesgu Measurable functions, Alzebras of measurable functions, Sequences of measurable function convergence in measure, Riese's Theorem simple Functions, Luzin's Theorem.
Unit-IV	**Positive borel measures** Vector Space-Topological Preliminaries-The Riesz representation theorem-Regularity properties of Borel measures.L^p SPACES :Convex function and inequalities-The LP Spaces-Approximation by continuous functions.
Unit-V	**Inventory control:** Deterministic and probabilistic model, price break inventory, Replacement, Renewal theory, maintenance and Reliability.Transportation Problem: A streamlined simplex method for the transportation, Problem, Stepping stone method, Transshipment problem.Assignment Problem: Traveling sales person problem.Queuing Theory: The Birth and Death process, queuing models involving non-exponential distributions, Priority-discipline queuing model, and Queuing networks.Project Management: Networks, shortest Route problem, Minimal spanning tree Problem, Maximum flow problem, project planning and control with PERTCPM.

Textbooks/References:

- Operations Research   : Hiller & Liberman
- Numerical Analysis   : Within and Heddley
- "Real & Complex Analysis" by walter rudin II Edition - Tata McGraw Hill Publishing Co. Limited, New Delhi.
- Measure and interation : Berbarian. S.K.
- Measure Theory : Halmos, P.R.
- Real analysis by H.L. Royden. 3rd editing- Prentice Hall and Publication
- An Introduction to Ordinary Differential equations by Eari a Cardington-Prentice Hall of India Publishers.
- Mumerical Methods for Scienctific and Engineering computation: Jain lynger.
- Numerical Analysis :   Sastri, S.S.

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Science & IT	Science	Botany	BOT019902

Unit-wise Content distribution

Unit	Contents
Unit-I	**Angiosperms ,Gymnosperms, Ethnobotany and biodiversity.** Recent trends in Taxonomy,Botanical Nomenclature, Herbaria and Botanical gardens.,Chemotaxonomy,Recent information on fossil history of angiosperms,Biosystematics and species concept, Ethnobotany: Histrorical background and importance of the study,Conservation and preservation of the endangered species.,Factors in the distribution of vegetation and floras. .Gymnosperms:-Trend in phylogeny and classification of Gymnosperms
Unit-II	**Algae, Bryophytes, Pteridophytes, Mycology and plant Pathology.** History with special reference to Indian work. Application of Algae, Bryophytes, Pteridophytes, Advances in plant pathology and economic important.New trends in the classification of Algae. Economic important. In Bryophytes, Pteridophytes,
Unit-III	**Molecular biology.** Cell organelles and their functions, DNA and RNA molecular structure. Recombinant DNA technology, Agrobacterium mediated gene transfer, , genome, genetic recombination, Gene Library, Plant tissue culture, vectors, restriction enzymes.
Unit-IV	**Advancement of Environment science** Soil waste management, rain water harvesting, Environment biotechnology sewage treatment, Field work, Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
Unit-V	**Instrumentation and Techniques.** Microscope, Microtome, Laminar air flow, centrifuge, auto clave, Hot air oven, chromatography, electronic balance, BOD, COD ,pH meter histological techniques, cytological techniques, PCR Souther and Northern techniques. Plant tissue culture techniques etc.

Textbooks/References:

Reference:

1. Schmidt-Nielsen K.(1995) Animal physiology, Adaptation and environment Cambridge university Press.
2. Bhatiya and Kohli fundamental of Ecology.
3. Veerbala Rastogi fundamental of Genetics.

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Science & IT	Science	Biotechnology	BIOT019902

Unit-wise Content distribution

Unit	Contents
Unit-I	**Plant Tissue Culture:** Sampling technique, sterilization technique, various methods for isolation of pure culture methods for measurement of microbial growth, manipulation of environment, nutritional and genetic parameters, maintenance and preservation of microbes (pure culture). Introduction to Cell & Tissue Culture. Design & lab setup of Tissue Culture laboratory, Tissue culture Media (Composition preparation), Types of culture.
Unit-II	**Chromatography:** Chromatographic techniques – Gel filtration, ion exchange chromatography, hydrophobic interaction and reverse phase chromatography, affinity chromatography, gas chromatography, high performance liquid chromatography, fast protein liquid chromatography; Application in separation of proteins including enzymes
Unit-III	**Molecular Biology And Spectroscopy:** Molecular Biology and spectroscopic techniques – Comet Assay; Real time PCR; RAPD, RFLP, ARDRA and Fluorescence *in- situ* hybridization techniques. Atomic absorption spectroscopy, infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectrometry including ESI MS and MALDI-TOF MS and Applications.DNA recombination techniques, gene splicing gene library, agro bacterium mediated gene transfer, vectors, restriction enzymes
Unit-IV	**Electrophoresis and centrifugation:** Electrophoretic and centrifugation techniques - SDS and Native PAGE, Agarose gel electrophoresis, isoelectric focusing and two-dimensional electrophoresis, proteome analysis; 2 Differential and density gradient centrifugation, analytical ultracentrifugation, separation of DNA/RNA using ultracentrifugation technique, determination of molecular weight and Sedimentation coefficient.
Unit-V	**Techniques and software analysis:** Quantitative methods; Principles and Designs of Experiments; Tools Parametric and Non~parametric statistics. Confidence interval, Errors. Levels of significance, Regression and Correlation coefficient. Analysis of variance for one way and two way classifications; Multiple Comparisons – Least Significant Difference Test, Duncan's New Multiple Range Test; Factorial Analysis; Analysis of Covariance

Textbooks/References:
1. Bergey's Manual of Systematic Bacteriology (2nd Ed.), Volumes1 to 4 Springer
2. The Search for Bioactive Compounds from Microorganisms by S. Omura
3. Continuous Culture (Vol. 8) by A. C. R. Dean, D. C. Ellwood and C. G. T. Evans
4. Annual Reviews in Microbiology Volumes 46 & 48 by L. N. Ornston, A. Balows and E. P. Greenberg (eds). Academic Press
5. Biotechnology: Current Progress Volume 1 by P. N. Cheremisinoff and L. M. Ferrante. Technomic Publishing Co. Inc

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	**Science & IT**	**Science**	ZOOLOGY	ZOO019902

Unit-wise Content distribution

Unit	Contents
Unit-I	**TAXONOMY AND DEVELOPMENTAL BIOLOGY:** Molecular basis of evolution. Affinities in Invertebrates. Evolution of vertebrates – Amphioxus as model – Various hypothesis on evolution of vertebrates. Early development of vertebrates. Early development of Invertebrates. Gametogenesis and early development-Physiological, chemical and molecular events.
Unit-II	**ENDOCRINOLOGY**:Histo-physiology of Hypothalamo-Hypo-physial axis, Endocrine regulation of calcium Phosphate homeostasis in the vertebrates. Pineal gland structure and its functions, Pineal-thyroid-gonadal axis and its role in various vertebrates. Endocrine function of kidney (aldosterone reninangiotensin system)
Unit-III	**ANIMAL BIOCHEMISTRY:** Hormonal control of carbohydrate, protein, and lipid metabolism, Metabolism of Na, K, Biological significance of trace elements Fe, Cu, Mg, Zn, Se. Evolution of hormones and Mechanism of action of hormones at cellular level and at genetic level, Membrane receptors, cAMP, IP3, DAG and ZN-fingers. Enzymes – Mechanism of enzyme action and kinetics, coenzymes, respiratory enzymes.
Unit-IV	**MOLECULAR BIOLOGY-** **Cell Organelles and their functions, DNA** and RNA structure, DNA techniques, Immunology, Vertebrate immune response, The B cell response, the T cell response, Carcinogen-Biology of cancer. The AIDS virus and its life cycle. Gene Library, genome, genetic recombination.
Unit-V	**INSTRUMENTATION-** Microscope, Microtome, Laminar air flow, centrifuge, auto clave, Hot air oven, chromatography, electronic balance, BOD, COD ,Ph meter histological techniques, cytological techniques, PCR Southern and Northern techniques. etc.

Textbooks/References:
1. Schmidt-Nielsen K.(1995) Animal physiology, Adaptation and environment Cambridge university Press.
2. Bhatiya and Kohli fundamental of Ecology.
3. Veerbala Rastogi fundamental of Genetics
4. Celis J.E.(1994):Cell biology – a laboratory hand book ,Vol.I,II,and III Acadimic press

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Science & IT	Science	**Environment Science**	ENVS019902

Unit-wise Content distribution

Unit	Contents
Unit-I	**Environmental Study –** Multidisciplinary nature of environmental studies Definition, scope and importance need for public awareness, Ecosystems- Energy flow in the ecosystem, Food chains, food webs and ecological pyramids. Material cycle (Gaseous and sedimentary).
Unit-II	**Biodiversity and its conservation** – Introduction – Definition: genetic, species and ecosystem diversity. Biogeographically classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels. India as a mega-diversity nation, wild life conservation. Hot Spots of biodiversity, threat to biodiversity, In-Situ and Ex –situ conservation of biodiversity.
Unit-III	**Environmental Pollution** – Definition • Cause, effects and control measures of :- a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards • Solid waste Management : Causes, effects and control measures of urban and industrial wastes. • Role of an individual in prevention of pollution. • Pollution case studies. • Disaster management: floods, earthquake, cyclone and landslides, speciation, variation, adaption, Niche and Habitat selection ,micro-ecosystem structure.
Unit-IV	**Natural Resources** – Renewable and non-renewable resources: Natural resources and associated problems. Over-utilization Resources, World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.
Unit-V	**– Instrumentation-** Microscope, Microtome, Laminar air flow, centrifuge, auto clave, Hot air oven, chromatography, electronic balance, BOD, COD ,pH meter histological techniques, cytological techniques, PCR Southern and Northern techniques. etc. Field work • Visit to a local area to document environmental assets river /forest/grassland/hill/mountain • Visit to a local polluted site-Urban/Rural/Industrial/Agricultural • Study of common plants, insects, birds. • Study of simple ecosystems-pond, river, hill slopes, etc.

Textbooks/References:

1. Schmidt-Nielsen K.(1995) Animal physiology, Adaptation and environment Cambridge university Press.
2. Bhatiya and Kohli fundamental of Ecology.
3. Veerbala Rastogi fundamental of Genetics.
4. Environmental Hydrology by Andy. D. Ward and William J.Elliot, Lewi
5. . Singh, Samar, 1986. Conserving India's Natural Heritage. Natraj Publisher, Dehradun.
6. . Hunter, Malcolm L. Jr. 1990. Wildlife, forests and Forestry : Principles of Managing
   Forests for Biodiversity, Englewood Cliffs. N. J., Prentice Hall
   7. Environmental Protection and Laws, Jadhav and Bhosale, V.M. Himalaya publishing House