Course No: CH18301CR
Title: Selected Topics in Inorganic Chemistry (04 Credits)

Max. Marks: *100* ***Duration:*** *64 Contact hours*
Continuous Assessment: *20 marks* ***End Term Exam:*** *80 Marks*

Unit-I Metal-ions in Biological Systems: (16 Contact hours)

The role of metal-ions in Metal-Protein systems; in trigger and control mechanisms; in structural context; as Lewis acid and as redox catalysts.

Biodistribution and biochemical role of essential trace and ultra-trace elements:- Fe, Zn, Cu, V, Cr, Mn, Ni, P, F and I. Effects of their deficiencies and treatment.

Antagonism and Synergism among essential trace elements.

Alkali and Alkaline earth metal ions (Na^+, K^+, Ca^{2+} & Mg^{2+}): Biological role; ligands and mechanism of ion transport (Facilitated transport, Carriers, Channeling and active transport of Cations).

Role of Lithium in mental health.

Chlorophyll: Structure and role of magnesium in photosynthesis.

Biological Nitrogen Fixation: Dinitrogen Complexes and their reactivity; Nitrogenase enzyme; Fixation via nitride formation.

Unit-II Bonding in Main Group Compounds (16 Contact hours)

Classification and topology of Boron clusters, types of bonds, isolobal analogy, empirical rules for bonding in boron clusters, Selected examples of bonding in higher boranes; Carboranes and Metallacarboranes.

Bonding in Boron–Nitrogen Compounds (Borazine), Phosphorous–Nitrogen compounds (Cyclophosphazenes, polyphosphazenes and phosphonitrillic halides), Sulphur-Nitrogen compounds (polythiazyls and Sulphur Nitrides)

Unit-III Magnetic Properties and Electronic Spectra of Transition Metal Complexes. (16 Contact hours)

Types of magnetic behaviour, magnetic susceptibility and magnetic moment; methods of determining magnetic susceptibility; spin-only formula; L-S coupling, correlation of μ_s and μ_{eff} values; orbital contribution to magnetic moments; applications of magnetic moment data in investigation of nature of bonding and stereochemistry of first row transition metal complexes. High spin- low spin crossover.

Electronic spectra of Transition metal complexes:- General features; Types of electronic transitions, theoretical aspects of d-d spectra, selection rules; spectral terms of d^1 - d^{10} metal ions.

Selected examples of d-d spectra. Spectra of distorted octahedral and square planar complexes. Charge transfer spectra.

Unit-IV NQR & Mossbauer Spectroscopy. (16 Contact hours)

Basic principles, Spectral parameters such as isomer shift, quadrupole splitting and magnetic splitting, spectrum display.

Application of the technique to the studies of (i) bonding and structure of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (ii) Sn^{2+} and Sn^{4+} compounds— nature of M—L bond, coordination number and structure, (iii) detection of oxidation state and inequivalent MB atoms.

NQR isotopes, Nuclear quadruple moment; Electric field gradient; nuclear quadruple coupling constant; Effect of applied magnetic field, Applications.

Books Recommended:

1. Bioinorganic Chemistry- An introduction; Ochiai; Allyn and Bacon; 1977.
2. Principles of Bioinorganic Chemistry; S. J. Lippard and J. M. Berg; University Science Books; 1994.
3. The Inorganic Chemistry of Biological Processes; IInd edn.; M. N. Hughes; John Wiley; 1973.
4. Bioinorganic Chemistry- A Short Course; R. M. Roat- Malone; Wiley Interscience; 2003.
5. Electronic Spectra of Transition Metal Complexes - D. Sutton (McGraw-Hill, 1968)
6. Elements of Magnetochemistry - R. L. Dutta, A. Syamal (Affiliated East -West, 1993).
7. Physical Methods for Chemistry; 2nd edn., R.S.Drago ; Saunders ; 1992.
8. Structural Methods in Inorganic Chemistry; 2nd edn. E. A. V. Ebsworth & D.W.H. Rankin; ELBS; 1991.
9. Spectroscopy in Inorganic Chemistry; Vols I& II; Rao, Ferraro; Academic;1970.
10. NMR, NQR and Mossbauer Spectrascopy in Inorganic Chemistry ; R.V.Parish; Ellis Horwood.

Course No: CH18302CR
Title: Organic Chemistry (Spectroscopy & Photochemistry) (04 Credits)

Max. Marks: *100* ***Duration:*** *64 Contact hours*
Continuous Assessment: *20 marks* ***End Term Exam:*** *80 Marks*

Unit-I Applications of Spectroscopy: (16 Contact hours)

Recapitulation of UV, IR Spectroscopy, Woodward-Fieser rule Characteristic absorptions of various functional groups. Interpretation of IR Spectra.

Mass Spectrometry: Introduction, instrumentation, Ionization methods like EI, CI, SIMS, FAB, MALDI, ESI, MS/MS. Mass Analyzers like Magnetic Sector Mass Analyzer, Double Focusing Mass Analyzer, Quadrupole Mass Analyzer, Time-of-Flight. Mass Analyzer Determination of Molecular Formula, Role of Isotopes, Nitrogen Rule, Metastable Peak. Fragmentation pattern like Stevenson rule , initial ionization event, α-cleavage, inductive cleavage, two bond cleavage, Retro-Diels. Alder cleavage, McLaffertey Rearrangements. Fragmentation pattern of alkanes, alkenes, alcohols, phenols, aldehydes, ketones, Carboxylic acids, Amines, Problems based on Mass Spectroscopy. Some specific examples from natural products like flavanoids terpenes, steroids, alkaloids.

Unit-II Nuclear Magnetic Resonance Spectroscopy: (16 Contact hours)

Basic concepts, Mechanism of Measurements, Chemical shift values for various classes of compounds. Fourier Transform (FT) , Techniques and advantages, Nuclear OVERHAUSER effect (NOE). One bond coupling, two bond coupling, three bond coupling, second order spectra A_2, AB, AX, AB_2, AX_2, A_2B_2. Proton exchange, deuterium exchange, Peak broadening exchange

C-13 NMR : Carbon 13-chemical shifts , proton coupled and decoupled spectra. Nuclear overhouser, Effect, Off-Resonance De-coupling, A quick dip in to DEPT-45 , DEPT-90, DEPT-135.

Introduction to two-dimensional spectroscopy methods, Cosy techniques, HETCOR technique, OESY, combined structure problems.

Unit-III Photochemistry-I. (16 Contact hours)

Photochemical Reactions

Interaction of electromagnetic radiation with matter. Types of excitations. Singlet and triplet states and their lifetimes. Fate of excited molecule: Physical and chemical processes. Transfer of excitation energy: Sensitization and Quenching. Quantum yield. Types of photochemical reactions.

Photochemistry of alkenes

Geometrical isomerisations, cyclisation and dimerisation reactions. Photochemical reactions of 1,3- butadiene (excluding pericyclic reactions). Rearrangements of 1,4 and 1,5- dienes.

Photochemistry of saturated carbonyl compounds

Intramolecular reactions of saturated acyclic and cyclic carbonyl compounds. (Norrish type-I and Norrish type-II processess). Intermolecular cycloaddition reactions (Paterno- Buchi reaction).

Unit-IV Photochemistry –II. (16 Contact hours)

Photochemistry of unsaturated carbonyl compounds

Photochemical reactions of α, β-unsaturated carbonyl compounds. (H-Abstraction and isomerisation to β, γ-unsaturated carbonyl compounds). Photolysis of cyclic α, β-unsaturated ketones (dimerisation and lumiketone rearrangement) and cyclohexadienones.

Photochemistry of Aromatic compounds

Photoinduced isomerisations of benzene and its alkyl derivatives. 1,2 ; 1,3 and 1,4 photoaddition reactions of benzene. Nueleophilic photosubstitution reactions in aromatic compounds. Photo Fries-rearrangement of aryl esters and anilides.

Miscellaneous Photochemical reaction

Photolysis of organic nitrites and their synthetic utility (Barton reaction).

Photochemistry of vision.

Books recommened:

1. Spectrometric identification of Organic Compounds. 5th Ed., R.M.Silverstein, G.C.Bassler and T.C.Morill. (Jhon Wiley-1991).
2. Introduction to NMR Spectroscopy, R.J.Abraham. J.Fisher and P.Loftus (Wiley-1991)
3. Applications of absorption spectroscopy of Organic Compounds, J.R.Dyer (Prentice Hall-1991).
4. Spectroscopic Methods in organic Chemistry, D.H.Williams; I.Fleming (Tata- McGraw Hill-1988).
5. Intoductory Photochemistry, A.Cox and T.Kemp (McGraw Hall-1971).
6. Organic Photochemistry, 2nd Ed., J.Coxon, and B.Halton (2nd Ed. Cambridge University press-1987).
7. Fundamentals of photochemistry, Rohtagi & Mukherjee (Wiley Eastern-1992).

Course No: CH18303CR
Title: Physical Chemistry (04 Credits)

Max. Marks: *100* ***Duration:*** *64 Contact hours*
Continuous Assessment: *20 marks* ***End Term Exam:*** *80 Marks*

Unit-I Quantum Chemistry (16 Contact hours)

Chemical Bonding: Hybridization of orbitals (sp, sp2 &sp3). Huckel's Pi-MO theory: Application to linear and cyclic polyenes. Pi-electron charge and bond-order. Alternant hydrocarbons, Naphthalene, heteroatomic conjugated systems. Limitations of Huckel theory. Parisar-Parr-Pople method, Extended Huckel Method.

Self consistent field method: Hamiltonian and wave function for multi-electron systems. Electronic Hamiltonian, antisymmetrized wave function, Slater determinant. Hartree and Hartree-Fock self consistent field method. One and two-electron integrals in the light of minimal basis H_2 system.

Unit-II Self-Assembly of Surfactants and its applications (16 Contact hours)

Classification of Surfactants, Solubility of Surfactants: Kraft temperature and cloud point, Micellization of surfactants: critical micelle concentration (cmc), aggregation number, counterion binding, factors affecting cmc in aqueous media. Thermodynamics of micellization: pseudophase model and mass action models. Structure and shape of micelles: geometrical consideration of chain packing, variation of micellar size and shape transitions with surfactant concentration, temperature and pH.

Micellar solubilization: Solubilization of hydrophobic molecules (like PAHs) in micelles, factors affecting micellar solubilization: nature of solubilizate and surfactant, effect of additive and temperature. Its applications in environmental remediation and oil recovery processes. Micelles as carriers of hydrophobic drug molecules and their pH and temperature responsive controlled release.

Micellar catalysis: Oxidation reduction reactions, micelles as scaffolds for effective energy transfer phenomena.

Unit-III Electrochemistry-I (16 Contact hours)

Electrified Interface: Metal-electrolyte electrified interface, concept of surface excess, thermodynamics of electrified interface, Lippman equation, electrocapillary curves. Methods for determination of surface excess. Structural models of metal-electrolyte interface: Helmholtz-Perrin, Gouy-Chapman and Stern models.

Theories of Heterogeneous Electron Transfer: Electron transfer at electrified interface at and away from equilibrium. Butler-Volmer equation, low and high field approximations, significance of transfer coefficient, Marcus theory of charge transfer; basics and predictions, relationship between Marcus theory and Butler-Volmer Kinetics, Marcus theory and experimental support.

Unit-IV Electrochemistry-II (16 Contact hours)

Photo-electrochemistry: Semiconductor electrodes: Structure of semiconductor/electrolyte interface. Band bending across Semiconductor/electrolyte solution interface, photo-electrochemistry across semiconductor/electrolyte interfaces, p-type photocathode, n-type-photoanode, surface effects in photo-electrochemistry, Photogalvanic and Photovoltaic Cells, The Efficiency of Solar Energy Conversion in Photoelectrochemical Cells, Liquid-Junction Solar Cells: Principles of Operation and Energetics of Conversion, Photoelectrochemical splitting of water, Photoelectrochemical reduction of CO_2.

Electrochemistry in Materials Science: Corrosion, types and mechanism of corrosion, corrosion current, corrosion potential, Electrodics of corrosion in absence of Oxide films, Corrosion and Evans diagrams, Monitoring and inhibition of corrosion; Cathodic and anodic protection, Passivation.

Books Recommended:

1. Physical Chemistry –P. W. Atkins, 9th Edition, ELBS , Oxford, 2009.
2. Physical Chemistry- A Molecular Approach - D. A. McQuarie & J. D. Simon, University Science Books, 1997.
3. Introduction to Quantum chemistry - A. K. Chandra, TataMcGraw Hill, 1997.
4. Quantum Chemistry - Ira. N. Levine, 7th Edition, Pearson, 2009.
5. Quantum Chemistry, R. K. Prasad, 2nd Edition, New Age Publishers, 2001.
6. Modern Electrochemistry 1, 2A, 2B 2nd Edition, J. O`M. Bokris and A. K. Reddy, Kluwer Academic/Plenum Publishers, New York.
7. Electrochemical methods, Fundamentals and Methods, A.J. Bard, L.R. Faulkner, Wiley,1980.
8. Physical Electrochemistry- Fundamentals, Techniques and Applications, Eliezer Gileadi, Wiley-VCH 2011.
9. Electrochemistry, 2nd Edition, Carl H. Hamann, Andrew Hammett, Wolf Vielstich, Wiley-VCH.
10. Semiconductor Electrochemistry, R. Memming, WILEY-VCH 2001.
11. Electrochemistry and Corrosion Science, Nestor Perez, Springer US, 2004.

Course No: CH18304CR
Title: Non-Equilibrium Thermodynamics (02 Credits)

Max. Marks: *50* ***Duration:*** *32 Contact hours*
Continuous Assessment: *10 marks* ***End Term Exam:*** *40 Marks*

Unit-I Fundamentals of Irreversible Thermodynamics (16 Contact hours)

Basic principles of non-equilibrium thermodynamics: Second law of thermodynamics for open system, law of conservation of mass, charge and energy. Irreversible processes and uncompensated heat, degree of advancement, reaction rate & affinity, Relation of uncompensated heat to other thermodynamic functions.

Gibb's equation, entropy production, entropy production due to matter flow, heat flow, chemical reactions, charge flow; entropy production and efficiency of galvanic cells.

Concept of forces & fluxes, Onsager's theory of irreversible processes, phenomenological laws, their domain of validity. Principle of microscopic reversibility and Onsager relations, Chemical reactions near equilibrium. Curie–Prigogine principle. Transformation properties of forces and fluxes.

Unit-II Applied Irreversible Thermodynamics (16 Contact hours)

Stationary non-equilibrium states, thermodynamic significance. Theorem of minimum entropy production. States of minimum entropy production, stability of stationary states, entropy flow in stationary systems. Stationary state coupling in irreversible processes. Variation of entropy production in stationery states, Glansdroff-Prigogine inequality. Electrokinetic phenomena and expressions for streaming potential, electro-osmotic pressure difference, streaming potential using the linear phenomenological equations. Dufour and Soret effects, Thermal Osmosis, Thermo mechanical effects, thermoelectric phenomena.

Self-Organization in physico-chemical systems, Dissipative structures, thermal convection, Symmetry breaking in biological systems.

Books Recommended

1. Thermodynamics of IrreversibleProcesses;DeGroot,Mazur;Dover;1986.
2. Introduction to Thermodynamics of Irreversible Processes; I.Prigogine; Wiley Interscience; 1967.
3. Thermodynamics for students of Chemsitry, Kuriacose, Rajaram, (S. ChandandCo., 1996).
4. Exploring Complexity, I.Prigogine, G. Nicolis, (Freeman, 1998).
5. Molecular Thermodynamics, D. A. McQuarrie, J. D. Simon, USB, 1998.
6. Understanding non-equilibrium thermodynamics. G. Lebon, D.Jon, J. Casas Vasques. Springer, 2008.
7. Non-equlibrium thermodynamics, 2nd ed. Yasar Demirel. Elsevier, 2007.

Course No: CH18305DCE
Title: Laboratory Course in Physical Chemistry (04 Credits)

Max. Marks: *100* ***Duration:*** *128 Contact hours*
Continuous Assessment: *20 marks* ***End Term Exam:*** *80 Marks*

A. Conductometry

1. Determination of the composition of a mixture of HCl and CH_3COOH by titration with standard NaOH.
2. Determination of degree of dissociation of a weak acid.

B. Potentiometry

1. Determination of strength and pKa value of weak acid by titration with an alkali using quinhydrone electrode.
2. Titration of Fe (II) vs. $K_2Cr_2O_7$ and determination of standard redox potential of Fe^{2+}/Fe^{3+}.

C. pH-metry

1. Determination of pKa values of a tribasic acid by titration with an alkali.
2. Determination of degree of hydrolysis of aniline hydrochloride.

D. Calorimetry

1. Determination of heat of neutralisation of a strong acid with a strong base.
2. Determination of heat of neutralisation of a weak acid with a strong base.

E. Spectrophotometry

1. Determination of composition of a binary mixture of $K_2Cr_2O_7$ and $KMnO_4$ or Cobalt (II) and Nickel (II) ions.
2. Spectrophotometric titration of Fe(II) vs. $KMNO_4$.

F. Chemical Kinetics

1. Determination of order of reaction between $K_2S_2O_8$ and KI by Initial rates method using clock reaction.
2. Compare the effect of ionic strength on the rate constant of persulphate-iodide reaction and iodide-Fe(III) reactions using clock method.
3. Determination of the rate constant of inversion of cane sugar catalysed be HCl using polarimeter.

G. Viscometry

1. Investigation of variation of viscosity with conc. and determination of unknown concentration.
2. Determination of the radius of a molecule by viscosity measurement.

Books Recommended:

1. Practical Physical Chemistry, Findley, Kitchener, Longman, 1977.
2. Advanced Practical Physical Chemistry, Yadav , Goel Pub, 1994.
3. Experiments in Physical Chemistry, 5th ed., Schoemaker et al. , MGH, 1989.

Course No: CH18306DCE
Title: Chromatographic Techniques (02 Credits)

Max. Marks: *50* ***Duration:*** *32 Contact hours*
Continuous Assessment: *10 marks* ***End Term Exam:*** *40 Marks*

Unit-I Chromatographic Techniques I (16 Contact hours)

Introduction, Types and Classification, principles, differential migration, nature of partition forces, partition, Mobile phases, stationary phases, resolution, plate theory (concept), separation time, zone migration, column packing materials, development techniques, differential migration, partition coefficient, retention time and retention volume.

Thin layer chromatography: Theory, principle, adsorbents, preparation of plates, solvents, preparative TLC.

Unit-II Chromatographic Techniques II (16 Contact hours)

Gas-Liquid chromatography: Principle, columns and stationary phase, resolution and instrumentation.

HPLC: Theory, column efficiency, extra column and band broadening, temperature effects and diffusion. Chiral chromatography, chiral stationary phases. Applications of HPLC.

Ion exchange and size exclusion chromatography: Principle, mechanism of separation and applications.

Books recommended

1. Principles and Practice of Analytical Chemistry; 5th Edition; F. W. Fifield, D. Kealey; Blackwell Sciences Ltd.; 2000.
2. Modern Analytical Chemistry; David Harvey; McGraw-Hill; 2000.
3. Chromatographic Methods; 5^{th} edn. ; A. Braithwaite and F. J. Smith; Kluwer Academic Publishers.
4. Fundamentals of Analytical Chemistry; 6^{th} Indian Reprint; D. A. Skoog and D.M. West; Cenage Learning; 2012.
5. Thin layer Chromatography; E. Stahl and George Allen; Unwin Ltd. London.

Course No: CH18307DCE
Title: Bio-Physical Chemistry (02 Credits)

Max. Marks: *50* ***Duration:*** *32 Contact hours*
Continuous Assessment: *10 marks* ***End Term Exam:*** *40 Marks*

Unit-I Biophysical Chemistry-I (16 Contact hours)

Review of the basic concepts of Thermodynamics, Thermodynamics of living systems, Biochemists standard state, standard free energy changes in biochemical reactions, ATP as energy currency of cell, Principles of coupled reactions. Nernst equation, Standard potentials: Thermodynamic standard potentials, variation of potential with pH, the biological standard potential, converting standard potential to a biological standard value. Electron transfer in bioenergetics; Electron transfer reactions, oxidative phosphorylation.

Biopolymers: Molecular forces and Chemical bonding in Bio-polymers, hydrophobic interactions, structure of proteins, protein folding and unfolding.

Binding of Ligands and metal Ions to bio-macromolecules, one binding site per macromolecule, n equivalent binding sites per macromolecule, the Scatchard plot, binding of oxygen to myoglobin and haemoglobin.

Unit-II Biophysical Chemistry-II (16 Contact hours)

Biological membranes, Structure and functions of cell membrane, molecular motion across membranes, ion transport through cell membrane, Mechanism of Membrane Transport: Transport through cell membrane, active and passive transport systems. Irreversible thermodynamic treatment of membrane transport. Semipermeable membrane and Donnan membrane equilibrium, Donnan effect in Osmosis, its dependence on pH difference across the membrane.

Membrane potential, Classical theory of membrane potentials; Nernst Equation, Nernst-Planck equation, permeability of membranes, Goldman-Hodgkin Katz model, Goldman equation, Nerve conduction; Action potential, factors affecting speed of action potential propagation, Nerve impulse and cardiovascular problems, Mechanism of vision. An introduction to bio-electroanalysis.

Books recommended

1. Physical Chemistry for the Biosciences, Raymond Chang, University Science Books, 2005.
2. Physical Chemistry for the Life Sciences,2nd Edition, Peter Atkins, Julio de Paula, Oxford University Press2015.
3. Biophysical Chemistry Part III: The behaviour of biological macromolecules, Charles R. Cantor and Paul R. Schimmel, W. H. Freeman and Company, New York, 2002.
4. Fundamentals of Biochemistry, D. Voet, J. G. Voet, C. W. Pralt, Wiley, 1999.
5. Lehninger Principles of Biochemistry, 7th Edition, Albert L. Lehninger, D. L. Nelson, N. M. Cox. W.H.Freeman & Co Ltd.

Course No: CH18003GE
Title: Bio-Organic Chemistry (02 Credits)

Max. Marks: *50* ***Duration:*** *32 Contact hours*
Continuous Assessment: *10 marks* ***End Term Exam:*** *40 Marks*

Unit-I **(16 Contact hours)**

(a) Chemical Origins of Biology

Bio organic chemistry: Introduction ,Basic consideration , Proximity effects in Organic Chemistry , Molecular rearrangments.

Pre-Biotic Chemistry: Role of HCN and HCHO in biosynthesis , Nucleophiles and Electrophiles in solution of HCN , Formation of Purines and Pyrimidines from HCN under prebiotic conditions .

Carbohydrates from Aldol reaction with HCHO , Formation of Amino acids under prebiotic conditions.

(b) Enzymes

Introduction Nomeclature and Classification of enzymes.

Specificity of enzyme action: Types of specificity , The active sites; The Fischer 'lock and key' hypothesis, The Koshland 'induced fit' hypothesis, Hypothesis involving strain or transition state stabilization.

Enzyme Inhibition: Introduction, Competitive inhibition, UnCompetitive inhibition, Non competitive, Allosteric inhibition.

Unit-II **(16 contact hours)**

(a) Coenzymes

Introduction, Types of coenzymes, Involvement of coenzymes in enzyme catalysed reactions: Introduction , Nicotinamide Nucleotides (NAD+ and NADP+), Flavin Nucleotides (FMN and FAD), Adenosine phosphate (ATP, ADP, AMP) .

Coenzyme A (CoA -SH) ,Thiamine Phosphate, Biotin, Tetrahydrofolate, Coenzyme B_{12} .

(b) Biosynthesis of Natural Molecules

Biosynthesis of Fatty Acids and Triglycerides, Biosynthetic Pathway of Terpenoids and Steroids, Inhibitors of Terpene biosynthesis, Biosynthesis of Flavonoids.

Books recommended

1. Introduction to bioorganic chemistry and chemical biology. D. V. Vranket and Gregary Weiss; Taylor and francis. 2013.
2. Bio-organicchemistry : Harman Dugas 3rd ed.Springer (2010) .
3. Bio-organic chemistry J.Rohr ,Springer (2000).
4. Enzymes 2nd ed. T. Palmer and P. Bonner (2008).
5. Biochemistry :Donald Voet, Judith.G. Voet 2nd ed.Willey (1995)

Course No: CH 18003OE
Title: Philosophy of Science (02 Credits)

Max. Marks: *50* ***Duration:*** *32 Contact hours*
Continuous Assessment: *10 marks* ***End Term Exam:*** *40 Marks*

Unit-I Representation (08 contact hours)

Laws of nature**:** Knowledge**, S**ources of knowledge, The rationalists, The empiricists, The Mathematical knowledge, Synthetic Knowledge, Science as knowledge source, Religion and science The Method of science, Induction versus deduction, Representation and reason, Probabilistic laws, Basic and derived laws,

Realism: Realism and its critics, Instrumentalism, Constructive empiricism, Laws and antirealism, Anti-realism and structure of science.

Unit-II Reason (08 contact hours)

Inductive Scepticism: Theory and observation, Dissolving the problem of Induction, Probability
and scientific inference, Kinds of Probability,

Inductive Knowledge: Reliabilist epistemology, reasoning with induction, Innate epistemic capacities and reasoning about induction, Internalism and justification.

Method and Progress: Methodology of scientific research programmes, Clinical trials and the scientific method, The content of discovery and the context of justification, Science without the scientific method, Method and the development of sciences, Paradigms and Progress.

Unit-III Classical Determinism and Probabilistic world (08 contact hours)

The Classical Mechanics: Mechanistic determinism, General principles; Action at a distance, Electric and magnetic forces, Failures of the classical mechanics;
Atomic structure, problem of radiation.

The birth of modern science**:** The photo-electric effect**,** The atomicity of radiation, Particle wave duality, waves of probability, Uncertainty principle, subject versus object, the fundamental laws of radioactivity, The new Quantum theory, wave mechanics, Diracs Quantum mechanics, The new philosophical principles, the probabilistic reasoning.

Unit-IV The Dawn of Modern Thinking (08 contact hours)

The arrow of Time: From Descarts to quantum theory, the relation of quantum theory to other natural sciences. Language and reality in modern science. The role of modern science in the present development of human thinking.

Books Recommended:

1. Philosophy of science; Alexander Bird; McGill-Queen's University Press.
2. Physics and Philosophy; W. Heisenberg; Harper Perennial Modern Classics.
3. Physics and Philosophy; Sir James Jeans; Cambridge University Press.
4. Reconstruction of religious thought in Islam; Muhammad Iqbal; Adam Publishers & Dodo Press.
5. Philosophy of natural science; Carl G. Hempel**;** Pearson.
6. The philosophy of science; David Papineaus; Oxford University Press.
7. Reality and Representation; David Papineaus; Blackwell Publication.
8. Belief, truth and knowledge; D.M. Armstrong; Cambridge University Press.
9. Modern epistemology; Nicholas Everitt and Alec Fisher; McGraw-Hill Higher Education.
10. The structure of scientific revolution; Thomas S. Kuhn; The University of Chicago Press