DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,

AURANGABAD.

DEPARTMENT OF CHEMISTRY

SYLLABUS

M. Sc. Physical Chemistry

(Semester III & IV)

Choice Based Credit and Grading System

Effective from : June 2017

The following will be the Choice Based Credit and Grading System structure of revised syllabus for M. Sc. III & IV semester Physical Chemistry effective from June 2017.

Semester	**Paper Nos.**	**Title of Paper**	**Teaching (hr)/week**	**Marks**	**Credits**
III- Semester	CHESC-301	Structural elucidation by spectral methods	04	100	04
	CHECP- 302	Solid state chemistry	04	100	04
	CHECP-303	Thermodynamics	04	100	04
	CHEEP -304	Advanced electrochemistry , **OR**	04	100	04
	CHEEP -305	Environmental chemistry, **OR**	04	100	04
	CHEEP-306	Nuclear chemistry	04	100	04
	CHELP-307	Laboratory course	06	50	03
	CHELP-308	Laboratory course	06	50	03
	CHEPR-309	Laboratory course	06	50	03
IV semester	CHECP-401	Surface and magnetochemistry	02	50	02
	CHECP -402	Polymer chemistry	04	100	04
	CHECP -403	Chemical dynamics and catalysis	04	100	04
	CHEEP -404	Nano chemistry ,**OR**	04	100	04
	CHEEP -405	Instrumental methods of chemical analysis, **OR**	04	100	04
	CHEEP-406	Biophysical chemistry	04	100	04
	CHEPR - 407	Research project (Experimental)	24	200	12
	CHEPR - 408	Research project (Dissertation Presentation and Seminars)	06	100	06

CHESC-301: Structural elucidation by spectral method

04 Hrs/Week **Credits: 04** **Marks 100**

UNIT-I: Nuclear Magnetic Resonance Spectroscopy (^{1}H NMR) [12hrs]

Elementary ideas (Recapitulation); Spin-spin couplings, Different types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB, AX, ABX, AMX), Rate processes, spin decoupling, shift reagents, Nuclear Overhauser effect (NOE), INEPT and INADEQUATE.

UNIT-II: ^{13}CNuclear Magnetic Resonance Spectroscopy [12hrs]

Elementary ideas, instrumental problems, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons); Effect of substituents on chemical shifts.

UNIT-III: Mass Spectroscopy [12hrs]

Introduction, ion production (EI, CI, FD and FAB), ion analysis, ion abundance, factors affecting on fragmentation, fragmentation of different functional groups, molecular ion peak, isotopic peaks, metastable peak, Nitrogen rule, McLafferty rearrangement, Retro-Diels-Alder reaction.

UNIT-IV [12hrs]

Problems based on joint applications of UV, IR, ^{1}H NMR, ^{13}C NMR and Mass spectroscopy.

UNIT-V [12hrs]

Mossbauer spectroscopy: Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds (temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals. **Electron Spin Resonance Spectroscopy:** Introduction, principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting diagram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications.

Reference Books:

1. Introduction to Spectroscopy: D. L. Pavia, G. M. Lampman, G. S. Kriz
2. Spectrometric Identification of Organic Compounds: R. M. Silverstein & F. X. Webster
3. ^{13}C NMR Spectroscopy: G. C. Levy, R. L. Lichter, G. L. Nelson

4. Spectroscopic Methods in Organic Chemistry: D. H. Williams & I. Flemming
5. Absorption Spectroscopy of Organic Compounds: V. M. Parikh
6. Mass Spectrometry: K. G. Das & James
7. Coordination Chemistry by Experimental Methods: K. Barger
8. Coordination Chemistry vol. I: E. Martell
9. Physical Methods for Chemistry: R. S. Drago
10. Structural Methods in Inorganic Chemistry: E. A. V. Ebsworth& D. W. H. Rankin
11. Organic Structure Analysis: Philips Crews

CHECP-302: Solid state chemistry

04 Hrs/Week **Credits: 04** **Marks 100**

Unit-I: Solid State Reactions **12 Hrs**

General Principles, Classification, Wagner reaction mechanism, Laws governing nucleation, Growth of nuclei, improving reactivity of solids, co precipitation as a precursor to solid state reactions, Kinetics of solid state reactions, factors affecting the reactivity of solid state reactions. General principles of growing single crystals, General conditions for crystal growth, solvent properties and saturated solutions, methods for growing crystals, slow evaporation, slow cooling, variation on slow evaporation and slow cooling, solvent diffusion, reactant diffusion, sublimation and seed crystals.

Unit-II: Imperfections in solids **12 Hrs**

Perfect and imperfect crystal, Point defects, Stiochiometric defects, Schottky and Frenkel defects. Thermodynamics of their formation, colour centers. Nonstoichiometric defects. Metal excess and metal deficiency defects. Line imperfections, edge dislocation and screw dislocation, Burger's circuits. Surface imperfection, `grain boundries and stacking faults.

Unit-III: Semiconductors and their devices **12 Hrs**

Intrinsic and extrinsic semiconductors, semiconductors materials and their fabrication, semiconductors devices p-n junctions, properties of p-n junctions, semiconductors diode as rectifier, Filters circuits, Zener diode as a voltage stabilizer, transistors transistor as an amplifier Super conductivity: conventional super conductors, organic super conductors (organic metals), fullerence, high temperature super conductors, organic charge transfer complexes Applications.

Unit-IV: Theories of solid state and properties of solids **12 Hrs**

Free electron theory, Conduction by free electrons, Band theory, refinement to simple band theory, band structure of metals. Insulator and semiconductors. Generation of x-rays, interaction of x-rays with matter, scattering and diffraction, Bragg's law, Miller indices, General instrumentation, Bragg's method, single crystal method, Debye-Scherrer method, Identification of unit cells from systematic absences, x-ray intensities and structure determination, structure factor and its relation to electron density and intensity, Phase problem. Indexing of lattice planes

in a cubic system, structure of NaCl and KCl, Avogadro's number from cubic lattice dimensions, applications of x-ray diffraction.

Unit-V: Ceramics **12 Hrs**

Introduction, major component of ceramics, clays, silica, feldspar, clay minerals, classification of clay minerals, properties of clay minerals, pillared clays, principal of pillaring, variety of pillaring species, modification of pillared clays, preparation of pillared clays, catalytic applications.

Reference Books

1. Solid State chemistry and its Applications-A. R. West (John Wiley and sons)
2. 2 Principles of Solid State –H.V. Keer (Wiley Eastern Limited)
3. Material science and Engineering-V.Raghavan (prentice Hall of India)
4. Principles of Electronics- V.K.Metha (S.Chand and co.)
5. Engineering chemistry –P.C. Jain and M. Jain (Shanpat Rai and Sons)
6. Industrial chemistry –B.K. Sharma (Goel publishing House)
7. Selected topics in solid state physics vol.12 The growth of crystals from liquids
8. J.C. Brice, North Hollond/American Elesvier(1973)
9. Chemistry of imperfect crystal-F.A. Krogen
10. Crystals and Crystal Growing, Alan Holden and Phylis Singer, Anchor Books Doubleday, New York, 1960
11. X-ray Structure Determination A Practical Guide, 2nd edition George H. Stout and Lyle H. Jensen, John Wiliey & Sons, New York, 1989.

CHECP-303 :Thermodynamics

04 Hrs/Week **Credits: 04** **Marks 100**

Statistical Thermodynamics

Unit-I: Introduction **12hrs**

Ensembles-canonical, grand canonical and micro canonical Combinatorial problems, Thermodynamics probability and most probable distribution, Stirlings approximation, distribution laws, the law of equipartition of energies. Quantum statistics- Max Well-Boltzmann, Bose-Einstein and Fermi-Dirac, limit and applicability of various distribution laws.

Unit-II: Molecular Partition function **12hrs**

Partition function, Expression for translational, rotational, vibrational and electronic partition functions, Third law of thermodynamics and partition function, Numerical problems.

Unit-III: Application to chemical systems **12hrs**

Partition function and Thermodynamic functions, Sackur-Tetrode equation (derivation), determination of equation of state of an ideal gas. Internal rotation, residual entropies, heat capacity of solids: Einstein model, Debye modification (model), characteristic temperature, statistical mechanics of solutions ideal and nonideal.

Unit-IV: Applications to quantum systems **12hrs**

Nuclear spin statistics, ortho and para nuclear states, ortho and para hydrogen.Fermi energy, Fermi energy of electron gas in metals, Plancks distribution law and radiation, Bose-Einstein degenerate gas (He gas).

Unit-V: Irreversible Thermodynamics **12hrs**

Postulates, entropy production in heat, entropy production in matter flow, entropy production in chemical reactions, Onsager's theory, microscopic reversibility and Onsager's reciprocity, stationary states and entropy production, Prigogine's principle of minimum entropy, application to thermoelectric effects-Seeback and Peltier effect.

Reference Books

1) Statistical Thermodynamics, Donaid A. Mc Qurrie, Harper & Row, New York 1973.

2) Statistical Thermodynamics, M.C. Gupta, Wiley Eastern Ltd. New Delhi.

3) Elements of Statistical Thermodynamics, L. K. Nash Addison Wesley, Menlo Park, 1972.

4) Physical chemistry, P. W. Atkins, ELBS

5) Non Equilibrium Thermodynamics, Progogine Kalyani Publication.

6) Thermodynamics and Non Equilibrium Thermodynamics, Gurudeep & Raj.

CHEEP-304 : Advanced electrochemistry

04 Hrs/Week **Credits: 04** **Marks 100**

Unit -I: Oxidation - Reduction Systems: 12 Hrs

Oxidation potentials, reversible ox-red systems, determination of standard ox-red potentials, variation of ox-red potential, ox-red equilibria, ox-red systems in analytical chemistry, ox-red indicators, two stage ox-red , semiqinone formation constant. Numericals.

Unit-II: Bio- electrochemistry and Electrocatalysis 12 Hrs

Donnan membrane equilibrium, membrane potential, theories of membrane potential,introduction to electrocatalysis, relative power of electrocatalysts, mechanism of electrocatalysis, bioelectro catalysis, immobilization, application of enzymes on electrodes.

Unit-III: Electrodeposition 12 Hrs

Introduction, the electrogrowth of metals on electrodes , the reaction pathway for electro deposition, surface diffusion of ions, cathodic deposition of metals from solutions, factors affecting cathodic deposition of metals, electrochemical dissolution and passivity of metals, anodic dissolution of metals, film and adsorption theories of passivity.

Electroplating of metals, mechanism, throwing power of an electroplating bath, factors affecting throwing power, typical electrodeposition processes, and applications of electroplating of metals. Numericals.

Unit-IV: Polarization and Overpotentials 12 Hrs

Polarization, concentration polarization, decomposition potentials, over voltage, hydrogen, oxygen and metal overvoltages, types of overvoltages, factors affecting overvoltages, experimental determination of decomposition potential and overvoltage, Tafels theory and Tafel equation, simultaneous deposition of metals .Numericals .

Unit-V: Conversion and storage of electrochemical energy 12 Hrs

Introduction of storage cells, fuel cells, solar cells Types of storage cells (batteries) ,measure of cell performance , charging and discharging , introduction of classical batteries , modern batteries –zinc-air , nickel-metal oxide and lithium batteries.

Brief history of fuel cells, efficiency of fuel cells, hydrogen-oxygen fuel cell, phosphoric acid fuel cell, direct methanol and biochemical fuel cells; Solar cells introduction, principle and working of solar cells, advantages.

Reference Books :

1) Modern Electrochemistry, Vol 1,2A and 2B, John O" M Bokris

2) An Introduction to Electrochemistry, Samuel Glasstone.

3) Theoretical Electrochemistry, L.Antropov.

4) Advanced Physical Chemistry, Gurtu and Gurtu.

5) Principles of Physical Chemistry, Puri,Sharma and Pathania.

6) Text Book of Physical Chemistry, S. Glasstone

7) Physical Chemistry, Robert J. Silbey.

8) Physical Chemistry, G.K.Vemulapalli.

9) Physical Chemistry, Maron and Pruton.

10) Physical Chemistry, P.W. Atkins

CHEEP-305: Environmental chemistry

04 Hrs/Week **Credits: 04** **Marks 100**

Unit-I: Air Pollution **[12hrs]**

General considerations: polluted air, Types of pollution and units of measurements. Air quality standards, Sampling, Monitoring, Analysis of CO, Sources and sinks of CO pollution, Effects of CO on plants and humans, Control of CO pollution, Analysis of oxides of nitrogen, NOx sources and sinks of NOx pollution, Control of NOx pollution, Hydrocarbons and photochemical smog and its control, Analysis of hydrocarbon in exhaust gasses, Petrol and air, Sulpher dioxide sources, Analysis and control, Acid rain particulates and their effects on human and climate, Control of particulates.

Unit-II **[12 hrs]**

Water Pollution: Aquatic environment, Water pollutants, Sampling of water and its preservation Trace metals in water, Chemical speciation with special reference to Copper, Lead, Mercury and Arsenic. Water quality standards Water quality parameters.

Oxygen Demanding Wastes: Dissolved oxygen, Biological oxygen demand, Monitoring techniques and methodology with special reference to ammonia, Nitrates, Nitrites, Fluorides, Cyanides, Total hardness, Lead, Cadmium and Mercury. Detection and control of Detergents, oils, Pesticides, Sewage treatment.

Unit-III **[12 hrs]**

Chemical toxicology : Toxic chemicals in environment, Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, Sulphur dioxide, Pesticides and Carcinogens.

Soil analysis: Sampling of soil, Determination of water holding capacity, Determination of total nitrogen, phosphorous and sulphur in soil.

Unit-IV **[12hrs]**

Industrial pollution: Pollution due to cement industry, Distillery, Pharmaceutical (Drug) industries, Sugar industry, Paper and pulp industries, Thermal power plants, Nuclear power plants, Metallurgical industries, Polymer industries. Recycle, reuse, recovery, disposal, and management of solid industrial waste.

Unit-V: Pesticides and Environmental pollution [12 hrs]

Types of pesticides, , Insecticides and Herbicides . Effect of pesticides, Insecticides and Herbicides on environment , Physicochemical decomposition of pesticides, , Insecticides and Herbicides by soil microorganism and other living organism .

Reference Books

1. A. K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
2. S. L. Chopra and J. S. kanwar, Analytical, Agricultural Chemistry, Kalyani Publishers, New Delhi.
3. Environmental chemistry , V P Kudesia , Pragati prakashan , meerut.
4. R. K. Trivedy and P. K. God, Chemical and biological methods for water pollution studies, Environmental publications, co. New Delhi.
5. L. A. Richards, Diagnosis and improvement of saline and alkali soils. Oxford IBH publications co. New Delhi.
6. S. M. Khopkar, Environmentalchemistry, Environmental pollution analysis.
7. M. S. Creos and Morr, Environmental chemical analysis, American publications.
8. M. Sitting, Resources, Recovery and Recycling, Handbook of industrial waste.
9. Standard methods of water and waste water analysis, American public health association Washington D. C.
10. R. Gopalan and AmruthaAnand, "Environmental chemistry laboratory manual Emerald Publication.
11. Standards for water for drinking and other purposes, Beaurau of Indian Standards India.
12. Guideline for drinking water quality recommendations of world health organization, Geneva.
13. B. K. Sharma and H. Kaur, Environmental Chemistry, Guel publishing house Meerut.
14. Thomas G. Spiro and Willian M. Stigliani, Chemistry of environment.
15. Green Chemistry: An Introductory Text, Mike Lancaster, Royal Society of chemistry(2002)
16. New Trends in green Chemistry, V.K.Ahluwalia and M. Kidwai, Anamaya Publishers New Delhi, (2004)

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CHEEP:306 Nuclear chemistry

04 Hrs/Week **Credits: 04** **Marks 100**

Unit- I Nuclear particles and its properties [12 hrs]

The fundamental particles, roll call of elementary particles, composition of the nucleus, theories of nuclear composition, nuclear properties, mass defect and binding energy, nuclear stability explained by different factors.

Nuclear size and density, mechanical effects due to orbiting and spinning of nucleons, orbital angular momentum of the nucleons, Total angular momentum of the nucleons, magnetic quantum numbers, principal and radial quantum numbers, total angular momentum of nucleus, total magnetic nuclear angular momentum quantum number, magnetic properties of the nucleous, the neutron magnetic moment, the structure of nucleon the net magnetic moments, The spin of odd Z odd N nuclei, The Nordhein rule.

Unit- II: Nuclear models [12 hrs]

The shell model and its salient features, periodicity in nuclear properties- magic numbers, forces of nuclear potential, energy level in nuclear potential well, the sequence of filling the orbital including models, nuclear configuration. The liquid drop model, and its details and The Fermi gas model.

Unit-III: Radioactivity [12 hrs]

Historical, background, natural radioactive elements, general characteristics of α, β, γ rays, detection and measurement of radioactivity, the theory of radioactive disintegration, decay kinetics, units of radioactivity, parent daughter growth relationship- secular and transient equilibrium, theory of α decay, β decay – energetics of β decay problems of β decay, fermis theory of β decay, nuclear de-excitation – emission, numerical

Unit-IV: Nuclear Reactions [12 hrs]

Definition and Bethes notation, nuclear reaction energetic, nuclear reaction and threshold energy, characteristics of nuclear reactions, types of nuclear reactions, conservation in nuclear reactions, nuclear reactions cross section, cross section and reaction rate, the compound nucleus theory, general properties of compound nucleus, optical model, direct interaction model, specific nuclear

reactions- photonuclear reactions, stripping and pickup reactions evaporation, spallation, fragmentation, direct nuclear reactions, thermonuclear reactions.

Unit-V: Radiation chemistry and its applications [12 hrs]

Introduction of radiation with matter, primary effects due to charged particle/radiation, Linear energy transfer(LET), Bethes equation for LET, Bremsstrahulung, the cerenkov radians, interactions of electron with matter, interaction of neutrons with matter, interaction of heavy charged particles with matter, interaction of rays with matter, units for measuring radiation absorption, absorption in water **B.** Typical reactions involved in the preparations of isotopes: the scillard-chalmers reactions, radiochemical principles in the use of tracers, typical application of radioisotopes as tracers- chemical investigation, physio-chemical research, analytical applications, agricultural applications, industrial applications, use of nuclear radiations, radioisotope as a source of electricity

Reference Books.

1. Source of Atomic energy by s. Glasstance, D. Van Nostrand co. INC
2. Essentials of nuclear chemistry by H.J. Arnikar 4th Edn, New Age International(p) Ltd.
3. Introduction to Nuclear By chemistry B. G. Harvey,
4. Nuclear chemistry by M. G. Arora & M. Singh Anmol publication, New Delhi
5. Elements of nuclear chemistry by A. K. Srivastav, P. C. Jain, S. Chand & Co.
6. A text book of Nuclear chemistry by C.V. Shekar Deminant publication & distribution, New Delhi.
7. Radiochemistry & nuclear chemistry, 3rd edn G. chappin, Butterwerth-Heinemann.

CHELP-307 :Laboratory course

06 Hrs/Week **Credits: 03** **Marks 50**

Spectroscopy

1) To determine the indicator constant pK_{in} of an indicator by using half height method (Bromo cresol purpule) (DVJ-200)
2) To determine the stability constant of metal complex between 5-SSA and Fe^{+3} with help of Job's curve and Bent and French method (for weak complex) (DVJ-204)
3) To determine the concentration of Fe(II) and Cu(II) by spectrophotometric titration with EDTA.
4) To investigate the reaction kinetics between $K_2S_2O_8$ and KI by spectrophotometrically (TKC-223)
5) To determine simultaneously the dichromate and permagnate ions in the given solution.

Polarimetry

6) Determine the percentage of two optically active substances in a mixture.(TKC-194)
7) To investigate the complex ion formation between Fe(II) and thiocynate ion.
8) To study Kinetics of hydrolysis of sucrose by Hammett-Zuckerman approach.(DVJ)
9) Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using mono, di and trichloro acetic acid as catalyst.

Refractometry

10) Determine the refractive indices of series of solution of a salt and determine the concentration of the salt in the given unknown solution.
11) Study the variation of refractive indices with composition of mixture of carbon tetrachloride and ethyl acetate and determine the composition and molar refraction of the given unknown mixture.

Viscosity

12) Determine the variation of viscosity with composition of I) ethanol-water, II) methanol-ethylidene chloride, III) nitric acid- chloroform and and conform the formation of compound.(TKC-250)
13) Determine the molecular weight of macromolecules.(TKC-251)
14) Determine the iso-electric point of gelatin and examine the effect of aging by viscometric methods.(DVJ-29)

Flame Photometry

15) Estimation of Na, K, Li & Ca by flame photometry.

Reference Book

1. Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj
2. Experiments in chemistry – D.V. Jahagirdar

CHELP- 308 : Laboratory course

06 Hrs/Week **Credits: 03** **Marks 50**

Potentiometer

1) Titrate ferrous ammonium sulphate with cerric sulphate and find out formal redox potential of Fe^{+2}/ Fe^{+3} and Ce^{+3}/Ce^{+4} system
2) Titrate potentiometrically phosphoric acid solution against NaOH and calculate pK_1, pK_2 and pK_3 of the acid.
3) To determine the standard free energy changes ΔG^o and equilibrium constant for reaction $Cu + 2Ag^+ \longrightarrow Cu^{++} + Ag$ (TKC-167)
4) Determine the activity coefficient of silver ions using a concentration cell without transference.(TKC-154)

pH metry

5) To determine the proton-ligand stability constant of an organic acid and the metal-ligand stability constant of its complex by pH measurements.(TKC-176)
6) Determine the Hammett constant of a given substituted benzoic acid by pH measurements.(TKC-170)
7) Determine the pH values of various mixtures of sodium acetate and acetic acid in aqueous solution and hence find out the dissociation constant of the acid.(TKC-173)
8) To determine the hydrolysis constant of aniline hydrochloride by pH measurements. (TKC-174)

Conductometry

9) Conductometric titration of a mixture of strong acid, weak acid and a salt.(DVJ)
10) To determine the degree of hydrolysis and hydrolysis constant of sodium acetate conductometrically.
11) Determine the amount of trichloroacetic acid, monoacetic acid and acetic acid in a given solution by conductometric titration against sodium hydroxide solution.

Magnetochemistry

12) To determine the magnetic susceptibility and number of unpaired electrons in given compound.
13) Verification of Weidemann's law using nickel chloride solution.

Surface Tension

14) Study the effect of surfactant (n-propyl alcohol) at various concentrations on the surface tension of water and hence determine the limiting cross sectional area of alcohol molecule by stalagmometer.
15) To study the effect of surfactant on surface tension of water by parachor of a solid by stalagmometer.

Reference Book

3. Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj
4. Experiments in chemistry – D.V. Jahagirdar

CHELP-309 : Laboratory course

06 Hrs/Week **Credits: 03** **Marks 50**

Chemical Dynamics

1) Investigate the influence of ionic strength on the rate constant of the reaction between $K_2S_2O_8$ and KI.(TKC-335)
2) Determine the order of a reaction by 1) substitution method, (II) fractional change method and (III) differential method.
3) Investigate the reaction between bromic acid and hydrochloric acid.(TKC-335)
4) Investigate the kinetics of iodination of acetone.

Phase equalibria

5) Determine the critical solution temperature of phenol and water in presence of 1) 1% NaCl 2) 0.5% naphthalene 3) succinic acid
6) Construct the phase diagram of three-component system containing ethanol benzene and water.
7) Determine the equilibrium constant of the tri-iodide formation in aqueous solution by distribution method.
8) Determine the formula of the complex formed between cupric ion and ammonia by distribution method.

Adsorption

9) Investigate the adsorption of acetic / oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherm.

Thermodynamics

10) Determine the partial molar volume of ethanol and water in a given composition by density measurements.
11) To determine heat of neutralization of strong acid and heat of ionization of weak acid calorimetrically.
12) To determine the integral heat of solution of KNO_3.

13) To determine the heat of dissociation of benzoic acid in water.

14) To determine heat of precipitation of $BaSO_4$.

Turbidimetry

15) Determine the molecular weight of a given polymer by turbidimetry

Reference Book

1. Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj

2,. Experiments in chemistry – D.V. Jahagirdar

CHECP-401: Surface and magnetochemistry

02 Hrs/Week **Credits: 02** **Marks 50**

Unit-1: Surface Chemistry **[10 hrs]**

Adsorption, adsorption isotherms, Langmuir's unimolecular theory of adsorption statistical derivation of Langmuir's adsorption isotherm, BET theory of multilayer adsorption and its determination

Unit-2: Colloidal state of Matter **[10 hrs]**

Introduction to colloids, classification, properties, specific properties like,electrical properties, charge on colloidal particals, origin of charge, electrical double layer, electrokinetic properties,electrophoresis, electroosmosis, streaming potential, sedimentation potential, determination of size of colloidal particals, applications of colloids, Numericals.

Unit-3: Introduction to Magnetochemistry **[10 hrs]**

Definition of magetic properties, types of magnetic behaviour, sources of paramagnetism, Pascals constants and it's applications, Determination of magnetic susceptibility. Numericals.

Reference Book

1. K.J.Laidler, J.H.Meiser and B.C. Sanctuary, Physical Chemistry, Houghton Mifflin Company, New York, 2003.
2. A.W. Adamson, Physical Chemistry of Surfaces, 4 th edition, Interscience, New York, 1982.
3. G.K.Vemulapalli, Physical Chemistry, Printice Hall of India.
4. Gurtu and Gurtu , Advanced Physical Chemistry.
5. S.Glasstone, Text book of Physical Chemistry.
6. Gurdeep and Raj, Advanced Physical Chemistry.
7. A.R.West, Solid State Chemistry and its Applications, John Wiley and Sons, 2003(reprint 2009)
8. H.V.Keer, Principles of Solid State.
9. A.Earn Shaw, Introduction to Magnetochemistry, Academic Press.
10. J.Sharma, Magnetochemistry.
11. R.I.Dutta and Syamal, Elements of magnetochemistry.

CHECP-402 : Polymer chemistry

04 Hrs/Week **Credits: 04** **Marks 100**

Unit-I: Fundamentals of Biological Macromolecules [12 hrs]

Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Properties and classification of amino acids; Structures of nucleic acids, Protein structure and function, Properties of nucleosides and nucleotides, Composition of nucleic acids, Electrophoresis, Factors affecting on Electrophoretic Mobility; Types of Electrophoresis; Free electrophoresis and Gel electrophoresis; Electrophoresis in genetic analysis; DNA Sequencing and DNA foot Printing.

Unit-II: Macromolecules [12 hrs]

Introduction, Formation of synthetic high polymers classification, Polymerization reactions: Chain and Step. Average molecular weight, Number average weight, Methods of determination of molar masses of polymers; Viscosity, Osmometry, Molar mass of charged macromolecules, Donnan membrane equilibrium, Ultracentrifugation, light scattering, Diffusion.

Unit-III: Chemistry of Polymerization [12 hrs]

Chain polymerization: free radical polymerization, ionic polymerization, co-ordination polymerization, Ziegler-Natta catalysts. Step Polymerization: polycondensation, polyaddition, ring opening, electro chemical polymerization, group, Transfer polymerization, Polymerization techniques.

Unit-IV: Kinetics of Polymerization [12 hrs]

Free radical chain polymerization, Anionic polymerization, Cationic polymerization, Copolymerization, Free radical copolymerization, Ionic copolymerization, Copolycondensation.

Unit-V: Electronically Conducting Polymers [12 hrs]

Introduction, Theories of electronic conduction; Band theory of conduction, Hopping conduction, Super conduction, Mechanism of conduction, Doping mechanism, p-type, n-type, auto doping, Stimuli sensitive (smart) polymers, pH and temperature sensitive smart polymers, Applications: Photovoltaic devices, Sensors, LED and Solar cells, Electro chemical devices, Batteries etc.

Reference Book

1. Cantor, C. R. and Schimmel Biophysical Chemistry Vols. 1-3, W. H. Freeman (1980).
2. Lehninger, A.L., Nelson, D. L. and M. M. Lehninger, Principles of Biochemistry 4th Ed., W. H. Freeman (2004).
3. U. Satyanarayana; Biochemistry.
4. Upadhyay; Biophysical Chemistry.
5. L. Stryer, Biochemistry, 5th Edition, (2002) Freeman and Co. New York.
6. D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication.
7. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry 3rd Edition (2002) McMillan North Publication.
8. Polymer Science. By V. R. Gowariker, N. V. Viswnathan, Jayadev Sreedhar.
9. Polymers and Resins. By Brage Golding.
10. Electrical Properties of Polymers. By Tony Blythe and David Bloor.
11. Self doped conducting polymers. By Michael S. Freund and Bhavana Deore.
12. Polymer Science and Technology. By Premamoy Ghosh.

CHECP-403: Chemical dynamics and catalysis

04 Hrs/Week **Credits: 04** **Marks 100**

Unit-I: Kinetics of Complex Reactions [12 hrs]

Opposing or reversible reactions, parallel and competitive reactions, consecutive reactions, chain reactions, branched chain reactions and explosions, hydrogen-oxygen reactions, kinetics of polymerization-step wise and free radical polymerization Effect of temperature on rates of simple and complex reactions. Numericals

Unit-II: Reactions in solution [12 hrs]

Diffusion controlled reactions, substitution and correlation effect, Hammet equation, Taft effects, compensation effect. Electron transfer reactions, proton transfer reactions. Ion dipole and dipole-diople interactions. Influence of pressure on rate in solution. Numericals

Unit-III: Photochemical Reactions [12 hrs]

Introduction, low of photochemical equivalence, photocatalytic reactions, types of photocatalytic reactions, photooxidation, photoreduction, photosensitization, photocatalytic degradation. Chemiluminescence, photosynthesis. Numericals

Unit-IV: Homogeneous Catalysis [12 hrs]

Introduction, mechanism of catalysis, Acid-base catalysis, effect of pH on rate constant. Micellar catalysis, enzyme catalysis, factors governing rate of enzyme reactions, kinetics of enzyme catalysed reactions.Autocatalysis and oscillatory reaction, Lotka-Volterra mechanism, the brusselator, the eregonator, bistability, chemical chaos. Numericals

Unit-V: Surface reactions and Heterogeneous catalysis [12 hrs]

Unimolecular surface reactions, bimolecular surface reactions, effect of temperature on heterogeneous reactions, transition state theory and the rates of surface reactions, theory of heterogeneous catalysis, structure of solid surfaces, absolute rates of desorption's, electronic theories of chemistorption and heterogeneous catalysis. Preparation and characterization of catalysts, applications.

Reference Books

1. Chemical kinetics- E.S.Laidler pearson Education

Chemical kinetics and Reaction dynamics -Bul Houston

Chemical kinetics and Reaction Mechanism -F-Wilkinson-VanNostral Reinhdd

2. kinetics and Mechanism Of Chemical TransformationsJ. Rajaram Macmillan India Ltd J.C.Curiacose.
3. Physical chemistry- Atkin and D.Paula, Oxford University press
4. Physical chemistry- Berry, Rice, Ross Oxford University press
5. Physical chemistry-principles And Appllication in Biological Sciences -Tinoco, Sauer Pearson Education.
6. Physical chemistry-W.J.Moore.

CHECP-404: Nanochemistry

04 Hrs/Week **Credits: 04** **Marks 100**

Unit-I: General introduction & synthesis of nanomaterials by physical methods [12Hrs]

Objective of study, synthesis of nanoparticles by physical method, mechanical methods- high energy ball milling, melt mixing, method based on evaporation, physical vapour deposition with consolidation. Ionized cluster beam deposition. Laser vaporization, Laser pyrolysis, sputter diposition, electric arc deposition, Chemical Vapour Deposition (CVD).

Unit-II: Synthesis of Nanomaterials by Chemical Methods [12Hrs]

Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.

Unit-III: Analysis Technique [12Hrs]

Introduction, microscopes, electron microscopes,SEM, TEM, Scanning probe microscope (SPM), Scanning Tunnelling microscope, Atomic force microscope, X-ray diffraction, UV-visible and IR spectroscopy.

Unit-IV: Properties, types and application of Nanomaterials [12Hrs]

Properties of nanomaterials – Mechanical, electrical, optical, magnetic, semiconductor.

i. Some special nanomaterials – Carbon nanotubes, porous silicon, Arogels, Zeolites.

ii. Application – Electronic, energy automobiles, sport and toys, textile, cosmetics, domestic appliances, biotechnology, medical, space, defence & environment.

Unit-V: Thin films: [12Hrs]

Introduction, deposition by chemical reactions, deposition by electrochemical reaction, chemical vapor deposition of inorganic Thin films, chemical etching.

Reference Books:

1. Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
2. NANO- The next revolution –Mohan Surendra Rajan(Natioinal book Trust, India)
3. The British Glass Website- Types of Glass://www.britiglass.org.uk.

4. Fundamental of Nanotechnology – Gabor L. Hornyak, John J. Moore, Harry F. Tibbals, Joydeep Dutta.
5. Recent advances in the liquid phase synthesis of Inorganic Nanoparticles- B. LCushing, V. L. Kolesmichenko & C.J.O".Connor Chemical Review 104, 3893-3946.(2004)
6. Hand book of Thin film technology- H. R. Khan.
7. Thin film phenomenon- K. N. Chopra. Mcgrawa Hill publication
8. Material Science deposition & structure –Milton.

CHECP -405: Instrumental methods of chemical analysis

04 Hrs/Week **Credits: 04** **Marks 100**

Unit-I: General Introduction **[12hrs]**

Overview of Electrode Processes, Electrocapillary curve and electrocapillary maximum potential, exchange current, Ion selective electrodes: Types and construction of electrode, Glass electrode, Solid state electrode and precipitate electrode, Liquid-liquid membrane electrodes, Enzyme and gas electrode, Applications of ion selective electrodes, Reference electrodes, Mercury electrodes (DME, SME, HMDE), numericals.

Unit – II: Potentiometry and Coulometry **[12hrs]**

Potentiometry: Introduction, Instrumentation, Various electrodes in potentiometry:- Ion selective electrode, Liquid membrane electrode, Weston cell. Potentiometric titrations:- Types of potentiometric titrations, Variations in potentiometric titrations, Limitations, Numericals. **Coulometry:** Introduction, Principle, Technique, Coulometry at constant current and coulometry at controlled potential, Coulometric titration, Flowing stream coulometry, Applications, Stripping analysis.

Unit- III: Cyclic Voltammetry **[12hrs]**

Theory and origin of polarography, Interpretation of pornographic curves, Instrumentation of polarography, Differential pulse polarography, Factors affecting on polarographic wave. Introduction and beginning of cyclic voltammetry Range of cyclic voltrametric techniques, Limitations. The acceptable sweep rate range, The shape of the peak in potential sweep curves, The role of non- aqueous solution in cyclic voltammetry, Crieteria of reversibility of electrochemical reactions Quasi reversible and irreversible processes, Qualitative and quantitative analysis by cyclic voltametric techniques, Linear sweep voltammetry for reactions that include simple adsorbed intermediates and Numericals.

Unit-IV: Molecular Luminescence Spectrometry **[12hrs]**

Theory of fluorescence and phosphorescence, Instruments for measuring fluorescence and phosphorescence, Applications and photoluminescence methods, Chemiluminescence.

Unit – V: Thermal methods of analysis **[12 hrs]**

General introduction, classification of thermal methods of analysis thermogravimetry, principles, factors affecting thermal curve, thermogravimetric analysis, Derivative thermogravimetry, Differential thermal analysis - principles, factors affecting DTA curve, applications, differential scanning colorimetry - principles, instrumentation and applications, thermomechanical and dynamic mechanical analysis, thermometric titrations, numericals.

Reference Books:

1. Quantitative analysis -. Alexeyev. V
2. Instrumental methods of analysis – Chatwal and Anand.
3. Introduction to instrumental analysis – R. D. Braun.
4. Instrumental methods of analysis – Willard, Meritt, Dean and Settle.
5. Standard methods of chemical analysis – F. G. Welcher, Vol III, Part A& B.
6. Electroanalytical chemistry – H. W. Neurenberg.
7. Principles of electrochemistry – D. A. Maclines.
8. Ion selective electrodes – (John Wiley) Stulic.
9. Vogel's textbook of quantitative chemical analysis V edition by Jeffery Bassett Mendham Denney.
10. Modern Electrochemistry vol. I - John O'M Bockris
11. Modern Electrochemistry vol. II - John O'M Bockris
12. Analytical Chemistry – Gary D. Christian, 6^{th} edition
13. Principles of Instrumental Analysis–Skoog, F. J. Holler & J. A. Nieman.
14. Instrumental Methods of Chemical Analysis–Galen W. Ewing. 5^{th} edition

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CHECP- 406 : Biophysical chemistry

04 Hrs/Week **Credits: 04** **Marks 100**

Unit-I: Biomolecules and Bioenergetics [12 hrs]

Biomolecules and the cells, carbohydrates, lipids, proteins and amino acids, nucleic acids and nucleotides, enzymes and vitamins, Free energy change in biochemical reactions, exergonic, endergonic, hydrolysis, ATP Biological oxidation reaction

Unit-II: Centrifugation [12 hrs]

Basic principle of centrifugation, Instrumentation, desktop centrifuges, high speed centrifuge, the ultracentrifuge, analytical centrifuges, rotors, differential, density gradient, analytical centrifugation.

Unit-III: Electrophoresis [12 hrs]

Factors affecting electrophoretic mobility, types of electrophoresis, free electrophoresis, zone electrophoresis and gel electrophoresis, electrophoresis in genetic analysis, DNA sequencing and DNA foot printing.

Unit-IV: Isotopes in biology [12 hrs]

Radioactive decay, production of isotopes, interaction of radioactivity with matter, measurement of radioactivity, gas ionization methods, photographic method and excitation method, use of stable isotopes in biology, the tracer techniques, use of isotopes as tracer, commonly used isotopes safety aspects.

Unit-IV: Bio- statistical Analysis [12 hrs]

Frequency distribution, T- test, Chi- square test, analysis of varience, co-relation and regression.

Reference Books:

1. U. Satyanarayana; Biochemistry.
2. Upadhyay; Biophysical Chemistry.
3. L. Stryer, Biochemistry, 5th Edition, (2002) Freeman and Co. New York.
4. Lehninger, A.L., Nelson, D. L. and M. M. Lehninger, Principles of Biochemistry 4th Ed., W. H. Freeman (2004).
5. Biophysical Chemistry.- M. Satake
6. Biostatical Analysis- A. M. Mungikar

CHEPR-407 : Research project (Experimental)

24 Hrs/Week **Credit : 12** **200 Marks**

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CHEPR-408 :Research project (Dissertation, presentation and Seminars)

6 Hrs/week **Credit : 6** **100 Marks**

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