DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY SUBCAMPUS, OSMANABAD

DEPARTMENT OF CHEMISTRY

CHOICE BASED CREDIT & GRADING SYSTEM SYLLABUS

(CBC & GS)

M. Sc. I & II Year

(DRUG & ANALYTICAL CHEMISTRY)

(W.E.F. June, 2016)

M. Sc. DRUG AND ANALYTICAL CHEMISTRY I Year (SEMESTER I)								
Sem	**Course**	**Code**	**Subject Title**	**Credit**	**Teaching Hrs/Week**	**Marks**		**Total**
						Internal	**Final**	
I	Common	IC-100	Introduction to the Indian Constitution	2	2	10	40	50
	Core	CHEC-101	Inorganic Chemistry	4	4	20	80	100
		CHEC-102	Organic Chemistry	4	4	20	80	100
		CHEC-103	Physical Chemistry	4	4	20	80	100
	Foundation	CHEF-104	Analytical Chemistry	4	4	20	80	100
	Laboratory	CHEL-105	Laboratory Course-I	4	8	NA	100	100
		CHEL-106	Laboratory Course-II	4	8	NA	100	100
			Total	**26**	**34**	**90**	**560**	**650**
M. Sc. DRUG AND ANALYTICAL CHEMISTRY I Year (SEMESTER II)								
II	Research	CHER-200	Research Methodology	2	2	10	40	50
	Core	CHEC-201	Inorganic Chemistry	4	4	20	80	100
		CHEC-202	Organic Chemistry	4	4	20	80	100
		CHEC-203	Physical Chemistry	4	4	20	80	100
	Foundation	CHEF-204	Applications of Organic Spectroscopy	4	4	20	80	100
	Laboratory	CHEL-205	Laboratory Course-III	4	8	NA	100	100
		CHEL-206	Laboratory Course-IV	4	8	NA	100	100
			Total	**26**	**34**	**90**	**560**	**650**

Head
Department of Chemistry
Dr.Babasaheb Ambedkar Marathwada
University Sub Campus,Osmanabad

M. Sc. DRUG CHEMISTRY II Year (SEMESTER III)								
III	Core	CHECD-301	Applications of Molecular Spectroscopy	4	4	20	80	100
		CHECD-302	Bio-Organic & Green Chemistry	4	4	20	80	100
		CHECD-303	Organic Reactions & Rearrangements	4	4	20	80	100
	Elective	CHEED-304	Applied Organic Chemistry **OR**	4	4	20	80	100
		CHEED-304	Heterocyclic Chemistry	4	4	20	80	100
	Laboratory	CHELD-305	Laboratory Course-V	4	8	NA	100	100
		CHELD-306	Laboratory Course-VI	4	8	NA	100	100
	Service		Service Course	4	4	20	80	100
			Total	**28**	**36**	**100**	**600**	**700**
M. Sc. DRUG CHEMISTRY II Year (SEMESTER IV)								
IV	Core	CHECD-401	Introduction to Medicinal Chemistry	4	4	20	80	100
		CHECD-402	Drug Synthesis	4	4	20	80	100
		CHECD-403	Drug Action & Development	4	4	20	80	100
	Elective	CHEED-404	Pharmaceutical & Industrial Practices OR	4	4	20	80	100
		CHEED-404	Drug Regulatory Affairs	4	4	20	80	100
	Research	CHERD-405	Research Literature & Seminar	4	8	NA	100	100
		CHERD-406	Research Project (Experimental)	4	8	NA	100	100
		CHERD-407	Research Project (Dissertation & Presentation)	4	8	NA	100	100
			Total	**28**	**40**	**80**	**620**	**700**
			Grand Total	**108**	**144**	**360**	**2340**	**2700**

M. Sc. I & II Year (ANALYTICAL CHEMISTRY)								
Sem	**Course**	**Code**	**Subject Title**	**Credit**	**Teaching Hrs/Week**	**Marks**		**Total**
						Internal	**Final**	
I	Common	IC-100	Introduction to the Indian Constitution	2	2	10	40	50
	Core	CHEC-101	Inorganic Chemistry	4	4	20	80	100
		CHEC-102	Organic Chemistry	4	4	20	80	100
		CHEC-103	Physical Chemistry	4	4	20	80	100
	Foundation	CHEF-104	Analytical Chemistry	4	4	20	80	100
	Laboratory	CHEL-105	Laboratory Course-I	4	8	NA	100	100
		CHEL-106	Laboratory Course-II	4	8	NA	100	100
			Total	**26**	**34**	**90**	**560**	**650**
I	Research	CHER-200	Research Methodology	2	2	10	40	50
	Core	CHEC-201	Inorganic Chemistry	4	4	20	80	100
		CHEC-202	Organic Chemistry	4	4	20	80	100
		CHEC-203	Physical Chemistry	4	4	20	80	100
	Foundation	CHEF-204	Applications of Organic Spectroscopy	4	4	20	80	100
	Laboratory	CHEL-205	Laboratory Course-III	4	8	NA	100	100
		CHEL-206	Laboratory Course-IV	4	8	NA	100	100
			Total	**26**	**34**	**90**	**560**	**650**
III	Core	CHECA-301	Applications of Molecular Spectroscopy	4	4	20	80	100
		CHECA-302	Environmental Chemistry	4	4	20	80	100

		CHECA-303	Organic Reactions & Rearrangements	4	4	20	80	100
	Elective	CHEEA-304	Analytical Methods in Chemical Analysis **OR**	4	4	20	80	100
		CHEEA-304	Advanced Analytical Techniques-I	4	4	20	80	100
	Laboratory	CHELA-305	Laboratory Course-V	4	8	NA	100	100
		CHELA-306	Laboratory Course-VI	4	8	NA	100	100
	Service		Service Course	4	4	20	80	100
			Total	**28**	**36**	**100**	**600**	**700**
IV	Core	CHECA-401	Applied Analytical Chemistry-I	4	4	20	80	100
		CHECA-402	Applied Analytical Chemistry-II	4	4	20	80	100
		CHECA-403	Applied Analytical Chemistry-III	4	4	20	80	100
	Elective	CHEEA-404	Pharmaceutical, Clinical & Forensic Analysis **OR**	4	4	20	80	100
		CHEEA-404	Advanced Analytical Techniques-II	4	4	20	80	100
	Research	CHERA-405	Research Literature & Seminar	4	8	NA	100	100
		CHERA-406	Research Project (Experimental)	4	8	NA	100	100
		CHERA-407	Research Project (Dissertation & Presentation)	4	8	NA	100	100
			Total	**28**	**40**	**80**	**620**	**700**
			Grand Total	**108**	**144**	**360**	**2340**	**2700**

M. Sc. First Year (*First Semester*)

IC-100: INTRODUCTION TO THE INDIAN CONSTITUTION

50 Marks **30 Hours**

M. Sc. First Year (*First Semester*)

CHEC 101: INORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Theories of Metal–Ligand Bonding in Complexes **20 Hrs.**

Valence Bond Theory: Assumptions of VBT, VBT applied to Octahedral (inner & outer orbital) complexes, Limitations of VBT.

Crystal field Theory: Important features of CFT, Crystal field splitting of d–orbital in Octahedral, Tetrahedral, Square–planar and Tetragonal complexes, Crystal field splitting energy and its use, Factors affecting the magnitude of Δo, Applications of CFT, Limitations of CFT.

Molecular Orbital Theory: Molecular orbital theory applied to various octahedral complexes using suitable examples, Construction and explanation of molecular orbital energy level diagram of Octahedral, Tetrahedral, Square–planar complexes involving sigma– as well as Π–bonding.

Unit II: Reaction Mechanism of Transition Metal Complexes **20 Hrs.**

Classification of Inorganic reactions, Energy profile diagram with terminology, Types of ligand or nucleophilic substitution reactions in octahedral complexes with their mechanism, Reactivity of metal complexes with Valence Bond & Crystal Field theories approach, Acid hydrolysis and its factors affecting (atleast four factors), Base hydrolysis and its conjugate base mechanism, Anation reaction with mechanism, Reactions without metal–ligand bond cleavage, Nucleophilic substitution reactions in square planner complexes, Trans effect, Trans–directing series, Polarization and Π–bonding theories of trans effect, Applications of trans effect, Electron transfer redox reactions of complexes, Inner and Outer sphere redox reactions with features & mechanisms.

Unit III: Metal–Ligand Equilibria in Solution **05 Hrs.**

Thermodynamic vs. Kinetic Stability, Definition of Stability constant, Stepwise and Overall formation constants with relation, Factors affecting the stability of metal complexes with reference to the nature of metal ion, nature of ligand, chelate effect and steric effect. Determination of formation constants for binary complexes using Spectrophotometric and pH–metric techniques.

Unit IV: Symmetry and Group Theory in Chemistry **15 Hrs.**

Introduction to Symmetry, Symmetry operation, Symmetry elements, Point group and its classification (Cn, Dn, Special type), Schoenflies symbol for point groups, Determination of point group of H_2O, NH_3, CO_2, BF_3, C_2H_4, PCl_5, PCl_3, C_6H_6, $[PtCl_4]^{2-}$, HCl, CO, $[FeF_6]^{3-}$, Ortho–, meta– & para–disubstituted benzene molecules. Symmetry and stereoisomerisms, Definition of group, Properties of group, Group multiplication table, Subgroups, Classes, Matrix representation of symmetry elements and point groups, Reducible and Irreducible representations, Character of a representation (character of matrix and conjugate matrix), Properties of Irreducible representation, Great orthogonally theorem (without proof) and its importance, Construction of character table of C_{2v} & C_{3v} point groups, Mulliken symbolism rules for irreducible representations & its illustrations. Standard reduction formula, Direct product and its uses.

Reference Books:

1. Inorganic Chemistry, *IV^th Eds., Shriver and Atkins*, Atkins, Overton, Rourke, Weller, Armstrong.
2. Mechanism of Inorganic Reaction, *II^nd Eds.*, F. Basolo and R. G. Pearsons.
3. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson.
4. Advanced Inorganic Chemistry, Vol. I & II, Gurdeep Raj.
5. Concise Inorganic Chemistry, J.D. Lee.
6. Chemical applications of Group Theory, F.A. Cotton.
7. Symmetry and Spectroscopy of Molecules, *II^nd Rev. Eds., New Age Inter. Publishers 2009*
8. K. Veera Reddy.
9. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D Madan.
10. Advanced Inorganic Chemistry, Satyaprakash, G. D. Tuli, S.K. Basu, R.D. Madan.
11. Group Theory and Symmetry in Chemistry, Gurdeep Raj, Ajay Bhagi, Vinod Jain
12. Inorganic Chemistry, J. E. Huhhey, E.A. Keiter, R.L. Keiter, O.K. Medhi.
13. Symmetry and Group Theory in Chemistry, Mark Ladd.
14. Inorganic Chemistry, Holleman–Wiberg.
15. Reaction Mechanism of Metal Complexes, R.W. Hay.
16. Inorganic Chemistry, Willam W. Porefield
17. Inorganic Chemistry, J.E. House.

M. Sc. First Year (*First Semester*)

CHEC 102 : ORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Nature of Bonding in Organic Molecules **12 Hrs.**

Delocalized chemical bonding conjugation, Resonance, Hyperconjugation, Bonding in fullerenes, Tautomerism. Aromaticity in benzenoid and non–benzenoid compounds, Alternant and non–alternant compounds, Huckel rule, Annulenes, Aromaticity, homo–aromaticity, ψ–aromaticity, PMO approach, Crown ethers complexes and cryptands, Inclusion compounds.

Unit II: Reaction Mechanism: Structure and Reactivity **13 Hrs.**

Types of Mechanisms, Types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammonds postulates, Curtin–Hammett principle, Potential energy diagrams, Transition states and intermediates, Methods of determining mechanisms, Isotope effects, Hard and soft acids and bases, Generation, structure, stability and reactivity of carbocations, Carbanions, Free radicals, Carbenes and Nitrenes. Effect of structure on reactivity, Resonance and field effect, Steric effect, Quantitative treatment, The Hammett equation, Linear free energy relationship, Substituents and reaction constants, Taft equation.

Unit III: Stereo–chemistry **20 Hrs.**

Elements of symmery, Chirality, Enantiomeric and diastereomeric Relationships, R and S–, E and Z– nomenclature, Molecules with more than one chiral center, Threo– and Erythro– isomers, Prochiral relationships, groups and faces, stereospecific and stereoselective reactions. Optical activity in the absence of Chiral carbon (Biphenyls, allenes and Spiranes), Chirality due to helical shape, Methods of resolution, optical purity, stereochemistry of the compounds containing Nitrogen, Sulphur and

phosphorous, Conformations analysis of cycloalkanes, Mono and disubstituted cyclohexanes, decalins, Effect of conformation on reactivity.

Unit IV: Aliphatic Nucleophilic Substitutions **12 Hrs.**

The SN^2, SN^1, mixed SN^1 & SN^2, and SET mechanisms, Neighboring group participation by π and 6–bonds, anchimeric assistance. Nucleophilic at an allylic aliphatic trigonal and a vinylic carbon.

Reactivity: Effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophiles, regioselectivity.

Unit V: Aliphatic Electrophilic Substitution **03 Hrs.**

Bimolecular mechanisms –SE^2 and SE^i The SE^1 mechanisms. Electrophilic substitution accompanied by double bond shifts.

Reference Books:

1. Advanced Organic Chemistry, IV Edn –J. March
2. Stereochemistry of carbon Compounds – E. L. Eliel
3. Advanced organic chemistry, F. A. Carey and R. J. Sundberg
4. A guide book to mechanism in organic chemistry: Peter Sykes.
5. Mechanism and Structure in organic Chemisry ,E.S.Gould
6. Principle of Organic Synthesis: R.O.C. Norman.
7. Modern Methods of Organic Synthesis: W. Carruthers

M. Sc. First Year (*First Semester*)

CHEC 103 : PHYSICAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Differential Calculus **08 Hrs.**

A. Functions: Differentiation, Rules for differentiation, Applications of differential calculus including maxima and minima, Simple differentials with their applications to Chemistry.

B. Integral Calculus: Basic rules for integration, Integration by partial fraction and substitution, Permutation and combination probability and Thermodynamic probability, Graphical representation for linear equations.

Unit II: Chemical Dynamics **15 Hrs.**

Collision theory, Modified collision theory, Weakness of the collision theory, Theory of absolute reaction rates, Equilibrium hypothesis, Derivation of rate equation, Statistical mechanical derivation and thermodynamic formulation. Isotope effect on reaction rate. Primary salt effect. Dynamics of uni–molecular reaction, Lindmann, Hinshelwood, KRR and Slater's treatment for unimolecular reaction. Kinetics of fast reactions, Study of fast reaction by flow method, relaxation method, flash photolysis and NMR method. Reactions in solution: reaction between ions fluency of solvent–double sphere model, single sphere model, Influence of ionic strength, Numericals.

Unit III: Classical Thermodynamics **10 Hrs.**

Third law of thermodynamics Nernst heat theorem, the third law of thermodynamics, determination of absolute entropies of solids, liquids and gases. Partial molar properties: Partial molar free energy, chemical potential, partial molar volume and partial molar heat content and their significance, determination of these quantities, concept of fugacity and determination of fugacity

Non–Ideal Systems: Excess functions for non–ideal solutions, activity and activity coefficient. Debye Huckel theory for activity coefficient of electrolytic solutions; determination of activity anJ activity coefficient, ionic strength, Numericals.

Unit IV: Surface Chemistry **12 Hrs.**

A. Micelles:

Surface active agents, Classification of surface active agents, Micellization, critical micellar concentration (CMC), factors affecting the CMC of surfactants. Thermodynamics of micellizatioti, solubilization .micro emulsion.

B. Adsorption:

Surface tension, capillary action, pressure difference across curved surface (Laplace equation) vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm. estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces, Numericals.

Unit V: Electro–Chemistry **15 Hrs.**

Debye–Huckel theory of Strong electrolytes, Debye–Huckel–Onsager equation, Testing of the equation, Dehye–Falkenhagen, Wein effect, activity coefficient, mean ionic activity coefficient; Debye–Huckel limiting law ionic strength Electro capillary phenomena, and its measurements Effect of anions, cations and molecules on electro–capillary curves Electro capillary properties of mercury– solution interface. Lppmann equation. Structure of electrified interfaces –Helmholtz, Gouy–Chapman, Stern, Grahm, Devnathhan models.

References Books:

1. Mathematics for Chemists, Bhupendra Smgh (Pragati Prakashan).
2. Mathematical Techniques of Chemistry and other Physical Sciences, B. K. Sen. (Kalyani Publication)
3. Chemical Kinetics, Laidler (McGraw–Hill).
4. Kinetic and Mechanism of Chemical Transformations, J Rajaram & J.C. Curiacose.
5. Physical Chemistry, Atkins (Oxford).
6. Thermodynamics for Chemists, S. Gladstone (EWP. Neiv Dellir)
7. Physical Chemistry, G. M Barrow.
8. Advanced Physical Chemistry, Gurdeep Raj.
9. Micelles: Theoretical and Applied Aspects, V. Moroi (Plenum).
10. Text Book of Physical Chemistry – S. Glasstone (McMillan).
11. An Introduction lo Electrochemistry – S Glasstone (EWP. New Delhi).
12. Modem Electrochemistry. Vol. I and II – J.O.M. Bockris and A K.N Reddy (Plenum).
13. Electrochemistry: Principles, Methods and Application, C.M. A. Brett & A.M.O. Brett (Oxford).

M. Sc. First Year (*First Semester*)

CHEF 104 : ANALYTICAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Analytical Chemistry – A Perspective **05 Hrs.**

Basics of Analytical Chemistry, The nature of analytical Chemistry, The role of analytical chemists, Qualitative and quantitative analysis, Analytical methodology (Sampling, Sample dissolution, Conversion of the analyte to a measurable form, Measurments, Calculation and Interpretation of the measurements).

Unit II: Statistical Treatment of Analytical Data: **10 Hrs.**

Introduction, Error & its types, Significant figures, Accuracy and Precision, Methods of expressing accuracy, Methods of expressing precision, Statistical treatment of finite samples (Mean, Median, Range, Average deviation, Relative average deviation, Standard Deviation, Coefficient of Variation, Variance), Confidence limit, Tests of significance–the 'F' test, the student's 't' test, Rejection of results–'Q' test, Numericals.

Unit III: Volumetric and Gravimetric Analysis **12 Hrs.**

Volumetric Analysis – Titration, Equivalence and End point, Standard solutions, Indicators, Theory of indicators, Types of titrations in Volumetric analysis (Acid–Base, Precipitation, Redox, complexometric titrations with principle, sub–types, applications to each).

Gravimetric Analysis – Precipitation, Properties of Precipitates and precipitating reagents, Types of Precipitating reagents/agents (Inorganic, Organic, Reducing), Particle Size and Filterability of Precipitates (Factors determining size, mechanism of precipitate formation, Control of particle size), Colloidal Precipitates (Coagulation of colloids, Peptization of colloids), Crystalline Precipitates, Coprecipitation & its types, Post–precipitation, Precipitation from homogenous solution, Drying and Ignition of Precipitates.

Unit IV: Basic Separation Techniques: Distillation and Solvent Extraction **10 Hrs.**

Distillation, Fractional distillation, Distillation under vacuum, Theory of operation of distillation methods, Some practical considerations.

Solvent Extraction: Principle, Partition/Distribution coefficient and Distribution ratio, Classification of extractions, Mechanism of Extraction, Extraction by Chelation with equilibrium, Extraction by Solvation with equilibrium, Practical Illustrations – Extraction of metals, Extraction by Ion pair, Accelerated and Microwave assisted extraction, Solid phase extraction, Numericals.

Unit V: Chromatography **07 Hrs.**

Definition of Chromatography, Classification of Chromatographic methods, Theory of chromatographic techniques (plate theory, rate theory), Zone broadening, Development of the chromatograms (Frontal analysis, elution analysis, displacement analysis), Selection of chromatograph system, Qualitative and Quantitative analysis by chromatography.

Unit VI: Thin layer Chromatography **03 Hrs.**

Basic Principles, Experimental Techniques–Solvent systems, Plate development, Detection of components, Evaluation of chromatogram by different methods, Applications of TLC.

Unit VII: Column Chromatography **03 Hrs.**

Principle, Experimental Details, Theory of development, Column efficiency, Factors affecting column efficiency, Applications.

Unit VIII: Gas Chromatography **05 Hrs.**

Principles, Types of GC (Gas–Liquid and Gas–Solid), Instrumentation and Working of GLC (Carrier gas, Sample introduction system, Columns and Stationary Phases, Detectors), Theory of GLC (Theoretical plate concept, Calculation of number of theoretical plates, The van Deemter Equation, Resolution, Factors in Retention), Applications, Numericals.

Unit IX: High Performance Liquid chromatography **05 Hrs.**

Principle, Instrumentation (Solvent systems, Pumping systems, Sample Injection system, Columns, Detectors systems), Applications, HPLC adsorption and partition chromatography.

Reference Books

1. Quantitative Analysis, 6th Eds., R.A. Day Jr., A.L. Underwood
2. Fundamental of Analytical Chemistry, 8th Eds., D.A. Skoog, D.M. West, F.J. Holler, S.R. Crough.
3. Analytical Chemistry, 6th Eds. G D. Christian.
4. Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.O. Barnes, M. Thomas, B. Sivasankar.
5. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt Jr., J.A. Dean, F.A. Settle Jr.
6. Basic Concepts in Analytical Chemistry, S.M. Khopkar,
7. Quantitative Analytical Chemistry, 2nd Eds. James S Fritz and George H. Schenk Jr.
8. Handbook of Instrumental Methods for Analytical Chemistry, F. Settle.
9. Treatise on Analytical Chemistry: Vol. I to Vol. II–I .M. Kolthoff.
10. Modern Instrumental Analysis, Volume 47. Edited by S. Ahuja, N. Jespersen, Elsevier

M. Sc. First Year (*First Semester*)

CHEL 105 : LABORATORY COURSE I

(PART A: INORGANIC CHEMISTRY PRACTICALS & PART B: ORGANIC CHEMISTRY PRACTICALS)

100 Marks **120 Hours**

PART A: INORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

I) Separation and estimation of metal ions from the following binary mixture solution:

1. Copper–Nickel 2. Copper–Iron 3. Nickel–Zinc 4. Iron–Magnesium
5. Copper–Barium 6. Iron–Aluminum 7. Cadmium-Manganese 8. Iron-Calcium

OR

I) Separation & estimation of metal ions from the ternary mixture solution:

1. Copper–Nickel–Zinc 2. Copper–Nickel–Magnesium. 3. Iron–Nickel–Zinc
4. Silver–Nickel–Magnesium 5. Silver–Copper–Zinc.

II) Synthesize, characterization and estimation the amount of metal ion from the metal complexes:

1. $Ti(C_9H_8NO)_2{\cdot}2H_2O$ 2. VO $(acac)_2$ 3. Cis–$K[Cr(C_2O_4)_2(H_2O)_2]$
4. $[Mn(acac)_3]$ 5. $K_3[Fe(C_2O_4)_3]$ 6. $[Co(II)(Py)_2Cl_2]$
7. $[Co(III)(NH_3)_6]Cl_3$ 8. $[Co(III)(NO_2)(NH_3)_5]Cl_2$ 9. $[Ni(NH_3)_6]Cl_2$
10. $[Cu(NH_3)_4].SO_4.H_2O$ 11. $Hg[Co(SCN)_4]$ 12. $NH_4.[Cr(NH_3)_2(SCN)_4]$

Reference Book:

1) A Text book of Quantitative Inorganic Analysis A. I. Vogel.
2) Practical Inorganic Chemistry, Pass Geoffrey and Haydn Sutcliffe.
3) Advanced Practical Inorganic Chemistry :Gurudeep Raj;
4) Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn. Orient Logman Ltd.
5) M.A. Malati, Experiments in Inorganic/Physical Chemistry.

PART B: ORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

Qualitative Organic Analysis

Separation, Purification and Identification of binary/ternary mixture of organic compounds.

The two-components may be solid-solid, solid-liquid or liquid-liquid (non volatile)

The water soluble solid/liquid should also be given. Student should submit purified sample of the separated compound and prepare suitable derivatives of the compounds.

Reference Book:

1) A Text book of Practical Organic Chemistry- A. I. Vogel.

M. Sc. First Year (*First Semester*)

CHEL 106 : LABORATORY COURSE II

(PART A: PHYSICAL CHEMISTRY PRACTICALS & PART B: ANALYTICAL CHEMISTRY PRACTICALS)

100 Marks **120 Hours**

PART A: PHYSICAL CHEMISTRY PRACTICALS **(50 Marks)**

NON-INSTRUMENTAL EXPERIMENTS

Chemical Kinetics

1. To investigate the auto-catalytic reaction between potassium permanganate and oxalic acid.
2. Iodination of acetone
3. Determination of energy of activation of acid catalyzed hydrolysis of an ester.

Adsorption

1. Acetic acid on activated animal charcoal

Phase Equilibria

1. Three component system: Acetic acid, chloroform, water
2. To determine the CST of phenol-water system in presence of 1% NaCl

Surface Tension:

1. To determine the surface tension of a liquid by stalagmometer (drop number method)

INSTRUMENTAL EXPERIMENTS

pH metry

1. Determination of pKa of dibasic acid (Oxalic acid)
2. Determination of hydrolysis constant of aniline hydrochloride

Conductometry

1. Titration of $ZnSO_4$ / $MgSO_4$ against $BaCl_2$ and $Ba(CH_3COO)_2$ and calculation of amount of Sulphate Present .
2. Conductometric estimation of NH_4Cl with NaOH solution.

Potentiometry

1. To determine the basicity and pKa value of organic acids by potentimetric method.
2. Determine the solubility and solubility product of sparingly soluble salts.

PART B: ANALYTICAL CHEMISTRY PRACTICALS **(50 Marks)**

1. Extraction of organic compounds from natural sources
   - Isolation of caffeine from tea or coffee.
   - Isolation of nicotine (an alkaloid) from tobacco.
   - Isolation of piperine from black papper (piper rigrum).

- Isolation of lactose from milk.

2. Spectrophotometric (UV/VIS) estimations
    - Vitamin-C by ultraviolet spectrophotometer.
    - Amino acids using ninhydrin method.
    - Ascorbic acid.
    - Ascorbic acid in plant tissues.

Reference Books:

1. Organic Chemistry-A Lab Manual by Pavia, Lampman, Kriz, Engel
2. Advanced Practical Chemistry by J. Singh, L. D. S. Yadav, R. K. P. Singh, I. R. Siddiqui
3. Practical Biochemistry for Students by V. K. Malhotra
4. Methodology for Water Analysis (Third Edition-2006) by Indian Association of Aquatic Biologists (IAAB)

M. Sc. First Year (*Second Semester*)

CHER 200 : RESEARCH MENTHODOLGY

50 Marks **30 Hours**

1. Research:

Meaning and objective of research, types of research (basic, applied and patent oriented research), selecting a problem & preparing a research proposal for different types of research as mentioned above.

2. Literature survey and documentation:

Methods of Literature survey, Use of library, books, journals, e journals, thesis, chemical abstracts and patent data base, techniques of documentation, importance of documentation, uses of computer packages in documentation.

3. Technical writing:

Research report, paper, thesis writing [Title, abstract, key words, methodology, results, discussion, conclusion, acknowledgement, references, errata, foot notes], types of research paper [review article, research papers and short communications and meeting report], detailed study of 'Instruction to Authors' of IJPS journal, a thorough understanding of steps involved in submitting articles electronically to IJPS [registration, new article submission, tracking the process, submitting revised articles]. Impact factor, Rating, Indexing and citation etc.

4. Presentation: (Specially for oral)

Importance, types different skills, contained, format of model, introduction & ending, posture, gestures, eye contact, facial expressions, stage, fright, volume, pitch, speed, pause & language, visual aids & seating, questionnaire.

5. Research organizations and procurement of research grants:

Introduction to various research organization (DST, DBT, AICTE, UGC, CSIR, DRDO, ICMR) along with their function in India, sources for procurement of research grants.

Reference Books:

1. Research In Education- John V. Best, John V. Kahn 10thedition
2. Presentation skills - Michael Hallon- Indian Society for Institute education
3. Thesis projects in Science & Engineering - Richard M. Davis.
4. Thesis & Assignment - Jonathan Anderson
5 Writing a technical paper- Donald Menzel
6. Protection of industrial Property rights- P. Das & Gokul Das

7. Preparation for publication - King Edward Hospital Fund for London
8. Manual for the preparation of industrial feasibility studies

M. Sc. First Year (*Second Semester*)

CHEC 201 : INORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Spectroscopic Symbols **5 Hrs.**

Terms, States, Microstates, Inter–electronic repulsion, Spin–orbit vector coupling, Ground term and excited terms, Determination of terms symbol for d^1 to d^5 Configurations, Microstate table, Hunds rule, Fine, Hyperfine and Superhyperfine Splitting of Free ions, Racah Parameters, Numericals.

Unit II: Term Diagrams **5 Hrs.**

Weak and stronger field approach of terms, Orgel diagrams of d^1 to d^9 configuration in Octahedral and Tetrahedral environments, Correlation diagrams of d^1, d^2, d^8 and d^9 configuration in Octahedral and Tetrahedral environments, Non–crossing Rule, Tanabe–Sugano diagrams of d^2 and d^3 configurations of an octahedral environment.

Unit III: Electronic Spectra of Transition Metal Complexes **12 Hrs.**

Types of experimental recording of the spectra, Selection rule for electronic spectra, Relaxation in Selection rules, Band intensities, Intensity of d–d bands, Intensity of change transfer bands, Classification of Electronic spectra, Interpretation of electronic spectra of transition metal ions with suitable examples, Charge transfer spectra & its types with mechanism, Evaluation of D_q, B' and β parameters (Graphical and Konig method), Numericals.

Unit IV: Magnetic Properties of Transition Metal Complexes **08 Hrs.**

Types of magnetic materials, Magnetic moment, Electronic spectrum and structure of Cobalt and Nickel complexes. Anomalous magnetic moments, Account on various models used for the anomalous behavior of magnetism, Magnetic Exchange Coupling, Types of antiferromagnetism

Unit V: Chemistry of Metal Carbonyls **10 Hrs.**

Classification, Preparation, properties, structures and bonding in –iron carbonyls, $Ni(CO)_4$ $Co_2(Co)_8$ $Mn_2(CO)_{10}$, $Cr(CO)_6$, $Mo(CO)_6$, $W(CO)_6$, $C_{O4}(CO)_{12}$ and V $(CO)_6$, Effective Atomic Number (EAN or 18 electron) rule applied to these carbonyls. Structures of mixed carbonyls of transition metals and EAN rule applied to these carbonyls. Preparations of carbonylate ions, and carbonyl hydrides.

Unit VI: Metal Nitrosyl Compounds **05 Hrs.**

Classification, Preparations and properties of Nitrosyl halides (NOX), Metal nitrosyl, Compounds containing neutral NO, NO^- group, NO^+ group, Preparation, structure and application of Sodium Nitropruside, EAN rule applied to Nitrosyl compounds of Cobalt, Iron and Manganese, Significance of NO for the life of living animals.

Unit VII: Chemistry of Non–Transition elements **15 Hrs.**

General discussion on the properties of the non–transition elements, Synthesis, properties and structure of halides and oxides of the non–transition elements, Polymorphism in Carbon, Phosphorous and Sulphur, Synthesis, properties and structure of Boranes, Carboranes, Silicates, Silicones, Carbides, Phosphazenes, sulphur–nitrogen compounds, Structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, Interhalogens, Pseudohalides.

Reference Books:

1. Inorganic Chemistry, IVth Eds., *Shriver and Atkins*, Atkins, Overton, Rourke, Weller, Armstrong.

2. Inorganic Chemistry (III[rd] Eds.)– By G. Y. Miessler, D.A. Tarr.
3. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson.
4. Advanced Inorganic Chemistry, Vol. I & II, Gurdeep Raj.
5. Concise Inorganic Chemistry, J.D. Lee.
6. Chemical applications of Group Theory, F.A. Cotton.
7. Symmetry and Spectroscopy of Molecules, *II[nd] Rev. Eds., New Age Inter. Publishers 2009* K. Veera Reddy.
8. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D Madan
9. Advanced Inorganic Chemistry, Satyaprakash, G. D. Tuli, S.K. Basu and R.D. Madan.
10. Inorganic Chemistry, J. E. Huhhey, E.A. Keiter, R.L. Keiter, O.K. Medhi.
11. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw.
12. Inorganic Chemistry, Holleman–Wiberg.
13. Reaction Mechanism of Metal Complexes, R.W. Hay.
14. Inorganic Chemistry, Willam W. Porefield
15. Inorganic Chemistry, J.E. House.
16. Inorganic electronic spectroscopy,–A.B.P. Lever.
17. Element of Magnetochemistry– By A. Samal & R.L. Datta.
18. Introduction to Magnotochemistry – Alan Earnshaw.
19. Introduction to Ligand Field – B. N. Figgis

M. Sc. First Year (*Second Semester*)

CHEC 202 : ORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Aromatic Electrophilic Substitution **10 Hrs.**

The arenium ion mechanism , orientation and reactivity, energy profile diagram ,orto/para ratio, IPSO substitution , orientation in other ring system, recapitulation of halogenations , nitration ,sulphonation and friedel craft's reactions. Diazonium coupling.

Unit II: Aromatic Nucleophilic Substitution **5 Hrs.**

The SN^{Ar}, SN^{1}, benzyne mechanism, Effect of substrate structure, leaving group and attacking nucleophilic on reactivity

Unit III: Addition to Carbon–Carbon multiple bond **10 Hrs.**

Mechanism and streochemical aspect of addition reaction involving electrophile, Nucleophile and free radical, Regioselectivity and chemo selectivity, orientation and reactivity, Michael addition, Sharpless asymmetric epoxidation.

Unit IV: Addition to Carbon –Hetero multiple bond **12Hrs.**

Mechanism of Metal hydride reduction of saturated and unsaturated carbonyl compound, acid, ester and nitriles , Addition of Grignard reagent , Organo zinc and organo lithium reagent to carbonyl and unsaturated carbonyl compounds,Witting reaction , Mechanism of condensation reaction involving enolates–Aldol, Knovenagel, claisen , Mannich , Benzoin ,Perkin, Stobbe reaction , Hydrolysis of ester and amides.

Unit V: Elimination Reaction **08 Hrs.**

The E1, E2 and E1cs mechanism. Orientation of double bond , reactivity: Effect of substrate substance , attacking base , the leaving group and the medium , pyrolytic elimination .

Unit VI: Oxidation and Reduction **15Hrs.**

Oxidation : Introduction , different oxidative process, hydrocarbon –alkanes, aromatic ring s, alcohol, diol,s, aldehyde,ketones, Ketal and carboxylic acids,amine , hydramine, and sulphide ,Oxidation with Ruthenium tetraoxide, ,Iodobenzene diaacetate and Thallium (III) nitrate.

Reduction: Introduction, different reductive process , alkenes, alkynes and aromatic ring carbonyl compounds ,aldehydes, ketones,acids and their derivatives , epoxides , nitroso,azo and oxime groups, hydrogenolysis.

Reference Books

1. Advanced Organic Chemistry, IV Edn –J. March
2. Stereochemistry of carbon Compounds – E. L. Eliel
3. Advanced organic chemistry, F. A. Carey and R. J. Sundberg
4. A guide book to mechanism in organic chemistry: Peter Sykes.
5. Mechanism and Structure in organic Chemisry ,E.S.Gould
6. Principle of Organic Synthesis: R.O.C. Norman.
7. Modern Methods of Organic Synthesis: W. Carruthers

M. Sc. First Year (*Second Semester*)

CHEC 203 : PHYSICAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Quantum Chemistry **25 Hrs.**

A) Introduction to Quantum Mechanics

The Schrodinger equation, Discussion of solution of the Schrodinger equation to some model system viz particle in a one dimensional box and three dimensional box , Harmonic oscillator, Rigid rotor, the hydrogen atom, Numericals.

B) Approximate Methods

The variation Theorem, Linear variation principle, Perturbation theory (First order and non–degenerate), Applications of variation method and perturbation theory to Helium atom.

Theory of Angular Momentum: Angular momentum vector, Angular momentum operator, Commutation rules and their physical signification, Ladder operator, Orbital and Spin angular momentum, Addition of angular momenta: Russell–Saunder coupling scheme and term symbols, Numericals.

C) Molecular Orbital theory

Huckel Theory of conjugated systems, Application to ethylene, butadiene, cyclopropenyl radical and cyclobutadiene, Numericals

Unit II: Phase Rule **10 Hrs.**

Recapitulation of phase rule and terms involved in it, One component, Two component system(solid–solid, solid–liquid and liquid–liquid), Reduced phase rule, Three component systems, Partially miscible three liquid system: One partially miscible pairs, Two partially miscible pairs, Three partially miscible pairs, System composed of two solid and a liquid : Crystallization

of pure component only, Formation of binary compounds, Formation of ternary compounds, Formation of solid compounds, Partially miscibility of solid phases, Numericals.

Unit III: Crystallography **15 Hrs.**

Classification of solids on the basis of shapes, Crystal lattice and unit cell, Law of crystallography, Crystal symmetry, Lattice planes and their designation.

Principle of crystal structures: Close packing of atoms, packing of equal sized spheres in HCP, CCP, BCC structures, packing in ionic solids, ionic radius, radius ratio rule (3,4,6,8 co–ordinate structures), octahedral and tetrahedral voids, isomorphism and polymorphism, Numericals.

Unit IV: Photochemistry **10 Hrs.**

Absorption of light and nature of absorption spectra, Electronic transition, Franck–Condon principle, Photo–dissociation and pre–dissociation, Photo–oxidation and photo–dimerization, Photo–physical phenomenon, Jablonski diagram, Photo–physical pathway of molecular de–excitation, Difference between delayed fluoresesence and phosphorescence, Quenching of fluorescence, Formation of excimer and examples.

Reference Books

1. Quantum Chemistry, Ira N. Levine.
2. Quantum Chemistry, R.K.Prasad.
3. Quantum Chemistry, B.K.Sen.
4. Principle of Physical Chemistry, Puri, Sharma, Pathania.
5. Advanced Physical Chemistry, Gurdeep Raj.
6. Physical Chemistry, Maron and Prutton
7. Fundamentals of Photochemistry, Rohatgi – Mukherjee.
8. Photochemistry, J.G.Calvert and J.N.Pitts.
9. Photo–luminescence of solutions, C.A. Parrker
10. Photochemistry, A. Singh and R. Singh
11. Solid State Chemistry, D.K.Chakraborti.
12. Solid State Chemistry and its applications, A. R. West.
13. Principle of Solid State, H.V.Keer.

M. Sc. First Year (*Second Semester*)

CHEF 204 : APPLICATIONS OF ORGANIC SPECTROSCOPY

100 Marks **60 Hours**

Unit I: Ultraviolet-Visible Spectroscopy **07 Hrs.**

Various Electronic transition, Chromophores, Auxochromers, Bathochromic and Hypsochromic Shifts, Effect of solvent on electronic transitions, Woodward–Fieser rules dienes, enones and aromatic compounds, Applications.

Unit II: Infrared Spectroscopy **10 Hrs.**

Instrumentation and sample handling, Various vibrational transitions, Characteristic vibrationl frequencies of alkenes, alkynes, aromatic compounds, Carbonyl compounds, hydroxyl compound and amines. Factors affecting IR group frequencies, overtone, combination bands and Fermi resonance. Applications

Unit III: Nuclear Magnetic Resonance Spectroscopy **15 Hrs.**

Elementary Ideas, Chemical Shifts, Factors affecting chemical shifts, Spin–Spin coupling constants (J) Instrumentations, Different types of coupling, Factors affecting coupling constant, Karplus equation, Spin system (AB, AX, ABX, AMX, etc), Rate processes, Spin decoupling, Shift reagents, Nuclear over Hauser effect (NOE).

Unit IV: C^{13}-NMR Spectroscopy **10 Hrs.**

Elementary Ideas, Instrumental aspects, chemical shift (Aliphatic, Olefinic, Alkyne, Aromatic, Heteroaromatic & carbonyl carbon), Effects of constituents on chemical shifts. Two dimensional (2D) NMR techniques: COSY, NOESY, DEPT, APT, INEPT & INADQUATE.

Unit V: Mass Spectrometry **8 Hrs.**

Introduction, Ion production (EI, CI, FD & FAB), Ion analysis, Ion abundance, Factors affecting fragmentation, Fragmentation of different functional groups, Molecular ion peaks, Metastable peaks Nitrogen rule, McLafferty rearrangement, Retro-Diels Alder reaction.

Unit VI: Problems based on joint application of UV, IR, NMR & Mass spectroscopy **10 Hrs.**

Reference Books:

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein- 6th Edition
2. Spectroscopy of Organic Compounds, V.M. Parikh.
3. Organic Spectroscopy, P.S. Kalsi
4. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.L. Nelson.
5. Mass Spectroscopy, K.G. Das & James.
7. Spectroscopy Methods in Organic Chemistry D. H. Williams and I. Fleming

M. Sc. First Year (*Second Semester*)

CHEL 205 : LABORATORY COURSE III

(PART A: INORGANIC CHEMISTRY PRACTICALS & PART B: ORGANIC CHEMISTRY PRACTICALS)

100 Marks **120 Hours**

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PART A: INORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

Semi-micro Qualitative Inorganic Analysis

Three acidic & three basic radicals including basic radicals (like Ba, Ca, Mn, Zn, Cu, Na, K, V, Co, Pb, Cd, Ag, etc) and acidic radicals (like Carbonate, Chloride, Nitrate, Iodide, Oxalate, Acetate, Sulphate, etc)

Reference Books

1. A Text book of Quantitative & Qualitative Inorganic Analysis, A. I. Vogel.
2. Practical Inorganic Chemistry, Pass Geoffrey and Haydn Sutcliffe.
3. Advanced Practical Inorganic Chemistry :Gurudeep Raj;
4. Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn. Orient Logman Ltd.
5. M.A. Malati, Experiments in Inorganic/Physical Chemistry.

PART B: ORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

Multistep organic preparations will be taken.

Reference Books:

1. Organic Synthesis (Third Edition) by Michael B. Smith
2. Organic Synthesis by Clayden, Greeves, Warren, Wothers

M. Sc. First Year *(Second Semester)*

CHEL 206 : LABORATORY COURSE IV

(PART A: PHYSICAL CHEMISTRY PRACTICALS & PART B: ANALYTICAL CHEMISTRY PRACTICALS)

100 Marks **120 Hours**

PART A: PHYSICAL CHEMISTRY PRACTICALS (50 Marks)

NON-INSTRUMENTAL EXPERIMENTS

Chemical Kinetics

1. Determination of order of reaction by differential method
2. Comparison of acid strength by hydrolysis of ester

Viscosity

1. Determine the radius of molecule by viscosity measurements (glycerol / sucrose).

Adsorption

1. Oxalic acid on activated animal charcoal

Phase Equilibria

1. Three component system: Benzene, ethyl alcohol and water
2. To determine the CST of phenol-water system in presence of 0.5% naphthalene (or acid)

INSTRUMENTAL EXPERIMENTS

Refractometry

1. To determine the electron polarization and electron polarizability of a liquid.

pH metry

1. Determination of pKa of acid (Succinic acid)
2. Determination of hydrolysis constant of aniline hydrochloride

Conductometry

1. Solubility and solubility product of spranigly soluble salts.
2. Titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against alkali.

Potentiometery

1. Estimate the amount of halides present in the given mixture by titrating with $AgNO_3$ solution.
2. Titration of mixture of acids with base.

Polarimetry

1. To determine the percentage of two optically active substances (d-sucrose and d-tartaric acid) in a given solution.

PART B: ANALYTICAL CHEMISTRY PRACTICALS (50 Marks)

A) Redox titrations

1. Determination of the percentage of W/V of H_2O_2.
2. Determination of percentage of KBr.

B) Quantitative analysis

1. Determination of saponification value of an oil or fat.
2. Determination of iodine value of an oil or fat.

3. Determination of acid value of oil or fat.
4. Determination of dissolved oxygen (DO) in water sample.
5. Determination of biochemical oxygen demand (BOD) in water sample.
6. Determination of chemical oxygen demand (COD) in water sample.
7. Determination of acetic acid in commercial vinegar using NaOH.

Reference Books:

1. Organic Chemistry-A Lab Manual by Pavia, Lampman, Kriz, Engel
2. Advanced Practical Chemistry by J. Singh, L. D. S. Yadav, R. K. P. Singh, I. R. Siddiqui, J. Singh, J. Srivastava
3. Practical Biochemistry for Students by V. K. Malhotra
4. Methodology for Water Analysis (Third Edition-2006) by Indian Association of Aquatic Biologists (IAAB)

M. Sc. Second Year (*Third Semester*) Drug Chemistry

CHECD 301: APPLICATIONS OF MOLECULAR SPECTROSCOPY

100 Marks **60 Hours**

Unit I: General Introduction of Spectral Methods **05 Hrs.**

Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter–absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra, Basic elements of practical spectroscopy, Resolving power, Signal to noise ratio, Uncertainty relation and natural line width, Natural line broadening, Intensity of spectral lines, Energy levels, Selection rules, Components of spectrometer and their functions.

Unit II: Microwave spectroscopy **05 Hrs.**

Rotation of molecules, Rotational spectra, Diatomic molecules–rigid diatomic molecules, Intensities of spectral lines, Effect of isotopic substitution, Non–rigid rotator, The spectrum of non–rigid rotator, Polyatomic molecules, Technique and instrumentation in outline, Applications, Numericals.

Unit III: Vibrational Spectroscopy **15 Hrs.**

A. Infrared spectroscopy – Review of linear harmonic oscillator, The vibrating diatomic molecule, The simple harmonic oscillator, The anharmonic oscillator, The diatomic vibrating rotator, Vibration– rotation spectrum of carbon monoxide, Breakdown of Born–Oppenheimur approximation, The vibration of polyatomic molecules, Overtones and combination frequencies, The influence of rotation of the spectra of polyatomic molecules the influence of nuclear spin, Symmetric top molecules analysis by infra–red technique–Group frequencies, Outline of technique and Instrumentation.

B. Raman spectroscopy –Classical and Quantum of theory of Raman effect, Pure rotational, vibration and vibrational–rotational Raman spectra, Rule of mutual exclusion, Overtone and combination vibrations Rotational fine structure, Outline of technique and instrumentation, Applications.

C. IR & Raman Studies of Complexes

Origin of Molecular Spectra, Origin of Infrared and Raman Spectra, Modes of vibrations, Selection Rules for Infrared and Raman Spectra, Normal modes of vibrations in AB_2 (Linear/Bent), AB_3, AB_4, AB_5, Octahedral AB_6 molecules with factors affecting band frequencies.

Unit IV: X–ray Diffraction **05 Hrs.**

Generation of X–rays, Interaction of X–rays with matter, Bragg's law, Miller indices, Diffraction methods (Laue/Single crystal and Powder/Debye–Scherrer methods), General instrumentation, Factors affecting X–ray intensity calculations, Identification of unit cells from systematic absences, Structure factor and its relation to electron density and intensity, Indexing of lattice planes in cubic system, Structure of NaCl and KCl, Avogadro's number from cubic lattice dimensions, Applications.

Unit V: Electronic Spectroscopy **10Hrs.**

A. Atomic spectroscopy: Energies of atomic orbitals, Vector representation of momenta and vector coupling, Spectra of hydrogen and alkali metal atoms.

B. Molecular spectroscopy: Energy levels, Molecular orbitals, Vibronic coupling, Vibrational progression, Franck–Condon principle, Electronic spectra of polyatomic molecules.

C. Photoelectron spectroscopy: Basic principle, photoelectric effect, ionizatioprocess, Koopman theorem, Instrumentation (Sources for ESCA & AES, Vaccum System, Specimen & its manipulation, Analyzers, Detectors), Satellite peaks, Spectral splitting ESCA, Chemical shifts, PES spectra of simple molecule, Applications, Auger effect (KLL effect).

Unit VI: Mossbauer Spectroscopy **08 Hrs.**

Principle of Mossbauer spectroscopy, Instrumentation, Isomer shift and its factors affecting, Quadrupole splitting, Temperature Dependence of MB parameters, Zeeman Splitting (Six fingered MB lines), MB spectra of iron and tin compounds, Applications, Numerical.

Unit VII: Electron Spin Resonance Spectroscopy **12 Hrs.**

Introduction, Principle of ESR Spectroscopy, Instrumentation, Presentation of spectrum, Hyperfine splitting in some simple systems, Hyperfine splitting in various structure (Naphthalene anion radical, Pyrazine anion radical, Isomers of Xylene anion radicals, VO^{2+}, Quinoline radical, Isoquinoline radical, Quinoxaline radical, Anthracene radical, Phenanthracne radical, Pyrene radical, Alkyl halide radicals, Quinone & Isoquinone anion radicals, nitrogen/deuterium containing radicals), Hyperfine splitting diagram, 'g' value, g-marker, Factors affecting the magnitude of 'g' values, Determination of g-value, Zero field splitting, Karmers's degeneracy, Applications, Numericals.

Reference Books

1. Physical Methods in Chemistry, IInd Edition, R. S. Drago.
2. P.H. Rieger, Electron Spin Resonance: Analysis & Interpretation, RSC Publishing, 2007.
3. B. Simovic, Introduction to the Technique of ESR Spectroscopy. 2004.
4. Lund, M. Siotani, S. Shimada, Principles and Applications of ESR Spectroscopy, Springer.
5. P. Gutlich, E. Bill, A.X. Trautwein, Mossbauer Spectroscopy & Transition Metal Chemistry, Springer Publications, 2011.
6. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A & Part B, John Wiley & Sons Publishers.
7. Mossbauer Spectroscopy: Principles and Applications of the Techniques, A.G. Maddock.
8. An introduction to Electron Paramagnetic Resonance, *M. Bersohn & J.C.Baired,* W.A.Benjamin, Inc N.Y.
9. High resolution ESR Spectroscopy, F.Gerson (John Wiley & sons)
10. The Determination of Molecular Structure, P. J Wheatly
11. Physical Chemistry, G. M. Barrow
12. Instrumental Methods of Chemical Analysis, Chatwal Anand

13. A Text book of Physical Chemistry, A. S. Negi & S.C. Anand
14. Instrumental Methods of Chemical Analysis, Willard, Merritt, Dean & Seatle
15. Instrumental Methods of Chemical Analysis, B. K. Sharma
16. Instrumental Methods of Chemical analysis, R.D. Braun
17. Principles of Instrumental Analysis, Skoog and West
18. Fundamental of Molecular Spectroscopy, Banwell
19. Atomic and Molecular structure, Manas Chanda
20. Molecular Spectroscopy, B. D Acharya
21. Molecular Spectroscopy, Dyer
22. Spectroscopy Methods in Organic Chemistry D. H. Williams and I. Fleming

M. Sc. Second Year (*Third Semester*) Drug Chemistry
CHECD 302: BIO-ORGANIC AND GREEN CHEMISTRY

100 Marks **60 Hours**

Unit I: Enzyme **4 Hrs**

Introduction, Active sites, Mechanism of enzyme action, Inhibition, Isolation and purification of enzyme, enzyme kinetics, co-enzyme, enzyme models, chemical use of enzymes, Therapeutic application of enzymes, recombinant DNA technology

Unit II: Carbohydrates **10Hrs**

Confermation of monosaccharides; structures and function of important derivatives of monosaccharides like Glycosides, Deoxy sugars, Myoinositol, amino sugars, N-aceylmuranic acid and sialic acid, disaccharides and polysaccharides. Structural polysaccharides: Cellulose and Chitin. Storage polysaccharides: Starch and Glycogen. Structure and biological function of Glucosaminogycans or mucopolusaccharides. Carbohydrates of glycoproteins and glycolinides. Role of sugars in bio;logical recognition. Blood group substances, Ascorbic acid. Carbohydrate metabolism: Kreb's cycle, Glycolysis, Glyvogenolusis, Gluconeogenesis and Pentose phosphate pathways.

Unit III: Lipids **6 Hrs**

Fatty acids, essential fatty acids, structures and function of triglycerides, glyceropholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins and function, role in antherosclerosis. Properties of lipid aggregates-Micelles, Bilayers, liposomes and their possible biological functions. Biological membranes, Fluid mosaic model membrane structure. Lipid metabolism: Beta oxidation of fatty acids

Unit IV: Amino acids, Peptides and Proteins **10 Hrs**

Chemical and enzymatic hydrolysis of prteins to peptides, amino acid sequencing. Secondary structure of protein, forces responsible for holding of secondary structure a helix, beta-sheets, super secondary structure, triple helix structure of collagen.

Unit V: Nucleic Acids **10 Hrs**

Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible or Holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an Overview of replication of DNA, Transcription, translation and genetic code. Chemical synthesis of mono and dinucleosides.

Unit VI: Green Chemistry **10 Hrs**

Introduction, Ideal synthesis, theoretical and functional details of following eco-friendly synthetic protocols with suitable examples ad applications.

a) Neat synthesis (solvent free synthesis)

b) Non-volatile organic media and water as green media in organic transformations like ionic liquid, PEG and water.

c) Microwave irradiation as alternative energy source for the chemical transformations.

d) Heterogeneous catalysis / Immobile catalysis.

e) Ultrasound assisted synthesis.

Reference Books:

1. Bioorganic chemistry By Hermann Dugas.
2. Biotransformation in organic chemistry By K. Faber.
3. Enzymc structure and Mecahanism By Alan Faber
4. Enzyme Catalysis in organic synthesis Vol. 1 By Karlheinz Drauz and Herbert Waldmann.
5. Bioorganic, Bioinorganic and Supramolecular chemistry By P. S. Kalsi and J. P. Kalsi.
6. Organic Chemistry IV Edn G.Marc Loudon.
7. Green Chemistry By Paul T. Anastas and John C. Warner
8. Green Chemistry By Rashmi Sanghi and M. M. Srivastav

M. Sc. Second Year (*Third Semester*) Drug Chemistry

CHECD 303: ORGANIC REACTIONS & REARRANGEMENTS

100 Marks **60 Hours**

Unit I : Organic Reactions **15 Hrs**

Reaction, Mechanism and applications of following reactions: Gabriel synthesis, Streker amino acid synthesis, Ullmann, Mitsnobu, Favorski, Hofmann-Loffler-Freytag, Shapiro, Dakin, Von Richter, Henery, Mukaiyama reaction, Sonogishira reaction.

Unit II: Organic Rearrangements **15 Hrs**

Introduction

(A) Migration to Electron deficient Carbon: i) Pinacol-Pinacolone, ii) Wagner-Meerwein, iii) Demjanov, iv) Wolf, v) Benzil-Benzilic acid rearrangement.

(B) Migration to Electron deficient Nitrogen: i) Beckmann, ii) Hoffmann, iii)Curtius, iv) Lossen, v) Schimidt rearrangement.

(C) Migration to Electron deficient Oxygen: i) Favorskii, ii) Neber, iii) Dakin rearrangement.

(D) Electrophilic Rearrangement: i) Stevens, ii) Wittig, iii) Smile rearrangement.

Unit III: Pericyclic Reactions **15 Hrs**

Introduction, Classification, Molecular Orbital Conservation Approach

(A) Cycloaddition reaction: Cycloaddition reactions and their stereochemical aspects, Woodward-Haffman rule, Selection rule for cycloaddition reaction, Details with examples of Diels-Alder reaction, (2+2) cycloaddition, (1, 3) polar cycloaddition, Cycloaddition of alkenes with OsO_4 and ozone, Cheleotropic reactions, Analyses of cycloaddition by FMO, Mobius-Huckel and Corrlaion diagram methods.

(B) Electrocyclic Reaction: Electrocyclic reactions and their stereochemical aspects, Selection rule of electrocyclic reaction, Con-rotations and dis-rotations, Methods of analyses of the electrocyclic reactions: FMO, Mobius-Huckel and Correlation diagram approaches.

(C) Sigmatropic rearrangements: Sigmatropic rearrangements and their stereochemistry, Rules for Sigmatropic rearrangements, Examples on (1, 3), (1, 5), (1, 7), (3, 3), (2, 3) Sigmatropic shifts, Claisen, Cope, Oxy-cope, Aza-cope, Sommelet-Hauser

rearrangements, Ene reaction, Methods of analyses of the rearrangements: FMO, Mobius-Huckel and Correlation diagram approaches.

Unit IV: Photochemical Reaction **10 Hrs**

(A) Photochemistry of Alkenes: Intermolccular reactions of the Olefinic Bond-Geometrical Isomerism, Cyclization reactions, Rearrangement of 1, 4- and 1, 5-dienes.

(B) Photochemistry of Carbonyl compounds: Intermolecular reactions of the Carbonyl compounds-saturated, Cyclic and acyclic, β, γ-gamma unsaturated and α, β-unsaturated compounds, Cyclohexadienones, Intermolecular Cycloaddition reactions, Dimerizations and Oxetane formation.

(C) Photochemistry of Aromatic Compounds: Isomerization, Additions and Substitutions.

Unit V: Protecting Groups **5 Hrs**

Introduction, Principle, Protecting groups for alcohols, carbonyl, carboxylic acids, amino groups.

Reference Books:

1. Designing Organic Synthesis: S. Warren, Wiley.
2. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers
3. Protective Groups in Organic Synthesis: T. W. Greene, G. M. Wuts.
4. Organic Syntheis: Jagdama Singh and L. D. S. Yadav
5. Advanced organic Chemistry: Part A & B, Reactions and Synthesis, F. A. Carey and R. J. Sundberg.
6. Organic Synthesis: M. B. Smith.
7. Principle of organic synthesis: Norman and Coxon
8. Advanced organic chemistry: Jerry March
9. Organic Photochemistry: Robert Kan

M. Sc. Second Year (*Third Semester*) Drug Chemistry

CHEED 304: APPLIED ORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Organometalic Reagents **10 Hrs**

Principle, Preparation, Properties and applications of the mechanistic details: Li, Mg, Hg, Cd, Zn, Ce, Cu, Pd, Ni, Fe, Co, Rh, Sn, Cr, Ti, Si, and B compounds.

Unit II: Ylides and Enamines **10 Hrs**

Phosphorus, Nitrogen and Sulphur ylides: Methods of generation, reactivity and applications.

Unit III: Free Radical Reactions **10 Hrs**

Types of radical reaction, Free radical substitution mechanism, mechanism at an aromatic substrate, Neighbouring group assistance, Reactivity for aliphatic and aromatic substrates at a bridgedhead, reactiviy in the attacking radicals, The effect of solvents on reactivity. Allylic halogenations (NBS), Oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazoniu salts, Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction.

Unit IV: Polynuclear Hydrocarbons **10 Hrs**

Introduction, Comparative study of the aromatic character of linear and nonlinear Ortho fused Polynuclear Hydrocarbon. General methods of preparation of fluorine, anthracene and phenanthrene.

Unit V: Heterocyclic Compounds **10 Hrs**

Nomenclature and familiarity with the heterocyclic ring (3-7 members containing up to 3 heteroatoms. Detailed chemistry of Pyrozole, imidazole, oxazole, thiazole, thiazine, pyrimidines, pyrazines and zepines.

Unit VI: Retrosythetic Analysis **10 Hrs**

Creative Chemistry, Retrosynthetic backwards, Disconnection must correspond to known, reliable reactions, Choosing a disconnection, Multi step syntheses: avoid chemoselectivity problems, Functional group interconversion, two group disconnections are better than one, C-C disconnections, Donor and acceptor synthons, Two group C-C disconnections, Natural reactivity and Umploung.

Reference Books:

1. Designing Organic Synthesis: S. Warren, Wiley.
2. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers
3. Principles of Organic Synthesis: R. Norman and J. M. Coxon, Blackie Academic and professional.
4. Advanced organic Chemistry: Part A & B, Reactions and Synthesis, F. A. Carey and R. J. Sundberg.
5. Organic Synthesis: M. B. Smith.
6. Principle of organic synthesis By Norman and Coxon
7. Advanced organic chemistry By Jerry March
8. Organic synthesis By W. Carruther

OR

M. Sc. Second Year (*Third Semester*) Drug Chemistry

CHEED 304: HETEROCYCLIC CHEMISTRY

100 Marks **60 Hours**

Unit I **15 Hrs**

Five and six membered heterocycles with one and two hetero atoms:

Synthesis, reactivity, aromatic character and importance of following heterocyclic rings: Furan, Pyrrole, Thiophene, Pyrazole, Imidazole, Pyridine

Unit II **15 Hrs**

Condensed five and six membered heterocycles: Benzofuran, Indole, Quinoline

Unit III **15 Hrs**

Condensed five membered heterocycles: Benzoxazole, Benzthiazole, Benzimidazole

Unit IV **15 Hrs**

Five and six membered heterocycles with more than two hetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocycles: 1,2,3-triazole, 1,2,4-oxadiazole, 1,2,5-oxadiazole, tetrazole

Reference Books:

1. Heterocyclic Chemistry: vol. I, II, III: R. R. Gupta, M. Kumar and M. Gupta
2. Heterocyclic Chemistry: Joules and Mills
3. Modern heterocyclic Chemistry: L. A. Paquette (Benjamin)
4. Organic Chemistry: Jonathan Clayden

M. Sc. Second Year (*Third Semester*) Drug Chemistry

CHELD 305 : LABORATORY COURSE V

(PART A: DRUG SYNTHESIS & PART B: DRUG ASSAY)

100 Marks **60 Hours**

PART A: DRUG SYNTHESIS **(50 Marks)**

PART B: DRUG ASSAY **(50 Marks)**

M. Sc. Second Year (*Third Semester*) Drug Chemistry

CHELD 306 : LABORATORY COURSE VI

(PART A: Organic Spectral interpretation & PART B: Analytical Spectral interpretation)

100 Marks **120 Hours**

PART A: Organic Spectral interpretation **(50 Marks)**

1. UV-Visible
2. ^{1}H NMR
3. ^{13}C NMR
4. Mass Spectroscopic

PART B: Analytical Spectral interpretation **(50 Marks)**

1. XRD
2. Mossbauer Method
3. ESR
4. Polarographic methods

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry

CHECD 401: INTRODUCTION TO MEDICINAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Introduction to Drug **30 Hrs**

What are Drugs? Definition, Characteristics of ideal drugs, Why do you need drugs?

(A) Classification of Drugs: i) Based on the chemical structures; examples of each class; ii) Based on the Pharmacological action; examples of each class, Physiological action, Pro-drug; mode of action

(B) Sources of Drugs: i) Plant sources; examples of methods of isolation; ii) Marine sources; examples of methods of isolation; iii) Micro-organism sources; examples of methods of isolation

(C) Historical development of Medicinal Chemistry, Genetic engineering

(D) Development of drugs: Lead discovery, lead development; Pharmacological / Microbiological / Biochemical evaluation of drugs; Clinical trials; Pharmacokinetic: i) Absorption, ii) Distribution, iii) Metabolism, iv) Elimination

(E) Dosage forms; Need and Benefits; Mode of administration of drugs; Types, Advantages; Disadvantages.

(F) Drug Toxicity and its prevention: Principles of toxicology, abnormal action of drugs such as tolerance, addiction, habituation, idiosyncracy, allergy, hypersensitivity, antagonism, synergism, potentiation, tachyphylaxis. Adverse drug reactions and its monitoring.

Unit II: Alkaloids **15 Hrs**

Introduction, Occurrence, Functions of alkaloids in plants, Nomenclature, Isolation, Structure determination and synthesis of papavarine, morphine, quinine, nicotine, atropine, cocaine, ephedrine, adrenaline, piperine.

Unit III: Terpenoids **15 Hrs**

Introduction, Classification, Isolation, Structure elucidation and synthesis of Monoterpenoids, Sesquiterpenoids, Diterpenoids, Triterpenoids, Carotenes.

Reference books:

1. Medicinal chemistry (Vol. I and II)-Burger.
2. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
3. Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
4. Medicinal Chemistry- Ashutosh Kar
5. Medicinal Chemistry- Balkishen Razdan
6. Natural Products: Chemistry and Applications- S.V. Bhat, B.A. Nagasampagi, S. Meenakshi

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry
CHECD 402: DRUG SYNTHESIS

100 Marks **60 Hrs**

Chemical synthesis of different classes of drugs:

Unit I: Anti-Infective **08Hr**

Introduction, Different classes, Mode of action examples of synthesis of each class e.g. Penicillin, Cephalosporins (semi-synthetic), Chloramphenicol, Ciprofloxacin, Sulphonamides, Metronidazoie, Clotrimazole, Griseofulvin

Unit II: Psychoactive Drugs **10Hr**

Introduction, neurotransmitters, CNS depressant, general anaesthetics, mode of action of hypotics sedatives, anti-anxiety drugs, synthesis of some psychoactive drugs e.g. Diazepam, Barbiturates, Fluoxetine, Alprazolam.

Unit III: Cardiovascular drugs **08Hr**

Introduction, Cardiovascular diseases, Drug inhibitors of peripheral sympathetic function, central intercention of cardiovascular output, direct acting anterior dilators, synthesis of some cardiovascular drugs e.g. Atenelol, Captopril, Diltiazem, Reserpine, Prostaglandins.

Unit IV: Anti-neoplastic agent **08Hr**

Introduction, cancer chemotherapy, special problems; Role of alkylating agent and anti-metabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibiters, synthesis of some antineoplastic agent-e.g. Taxol.

Unit V: Analgesics and Anti-inflammatory **08Hr**

Introduction, Synthesis of some: Analgesis and Anti-inflammatory compounds e.g. Ibuprofen, Indomethacin, Diclofenac, Rofecoxib, Steroids: Introduction, Nomenclature, Structure elucidation Cholesterol, Bile acids, Estrogens, Gestogens, Androgens, Cortisone, Vitamins: A, D, E, K, Vitamin B, Complex, B_1, B_2, B_6, B_{12}, C, H.

Unit VI: Antiacids / Antiulcer **08Hr**

Introduction, synthesis: Omeprazole, Ranitidine.

Unit VII: QSAR Method **10Hr**

Introduction, Methods used in QSAR studies, Hansch method, Free-Wilson method, Advantage and disadvantage of free approach, Computer based methods of QSAR related to receptor binding, Physico-Chemical properties, Lipophilicity, Electronic parameters, Steric substituent constants, Experimental determination of partition coefficints.

Reference Books:

1. Synthesis of Essential Drugs- R. S. Vardanyan and V. J. Hruby, *Elsevier.*
2. Contemporary Drug Synthesis- J. J. Li, D. S. Johnson, D. R. Sliskovic, B. D. Roth, *John Wiley.*
3. Natural Products Chemistry- J. Singh, S. M. Alia and J. Singh, *Pragati Prakashan.*
4. Principals of Organic Synthesis- R. O. C. Norman and J. M. Coxon, *CRC Press.*
5. Advanced Organic Chemistry *Part B: Reactions and Synthesis*- F. A. Carey and R. J. Sundberg, *Springer.*
6. Natural Products: Chemistry and Applications- S.V. Bhat, B.A. Nagasampagi, S. Meenakshi.
7. Medicinal chemistry (Vol. I and II)-Burger.
8. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
9. Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
10. Medicinal Chemistry- Ashutosh Kar
11. Medicinal Chemistry- Balkishen Razdan

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry
CHECD 403: DRUG ACTION AND DEVELOPMENT

100 Marks **60 Hours**

Unit I: Drug Design- A Rational Approach

Introduction, Analogus and prodrugs, Concept of lead, Factors governing drug-design, Rational Approach to drug-design, Drug design-methods of variations, Drug design and development, Molecular hybridisation, rigidity and flexibility *vs* Drug-design.

Unit II: Physical-Chemical Factors and Biological Activities

Introduction, Physical properties, Factors governing ability of drugs, Dissociation constants, Isosterism and bio-isosterism, Stereochemistry and drug action, Chemical properties.

Unit III: Target of action of drugs

a) **Receptors:** Definition, mode of action: agonists, antagonists (description): Families of receptors

b) **Cell:** Definition, types, structure

c) **Nucleus:** Definition, types, nucleic acid, DNA (structure, drug, that work on DNA); RNA (structure, that work on RNA) Drugs related to nucleic acid and building blocks.

Unit IV: Mode of action and development of following classes of drugs

a) Cancer and anticancer drugs: Mechloroethamines hydrochlorides, Chloroambucil, Methotrexate, Daunorubicin, Colchicine.

b) Analgesics and anti-inflammatory: Indomethacin, Ibuprofen, Ibufenac, Indoprofen, Naproxen.

c) Antibiotic-Historical development and semi synthesis e.g. Penicillin,Cephalosporin's, Macrolides, Quinolones, Sulplhonamides and sulphones

d) Anti-malerials: Chloroquine phosphate, Pamaquine, Pyrimethamine, Dapsone, Trimethoprim.

e) Anti-virals and AIDS: Amantidine hydrochloride, Idoxuridine, Acyclovir, Ribavirin, Vitrasert, foscarnet.

) Anti-fungals: Griseofulvin, Chlormidazole, Naftifine, Flucytosine.

g) Cardiovascular disorders and managements: Hypertension, Myocardial infraction, angina, Arrythemia: Hydralazine, Clonidine, Diazoxide, Sodium nitroprusside, Propranolol.

h) Antidiabetics: Chlorpropamide, Metformin, Nateglinide, Rosiglitazone, Pioglitazone

i) Central nervous system and disorder managements Anticonvulsant, Antidepressant, Sedatives: Caffenie, Theobromine, Pemoline, Phentermine, Bemegride.

Reference Books:

1. Medicinal chemistry (Vol. I and II)-Burger.
2. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
3. Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
4. Medicinal Chemistry- Ashutosh Kar
5. Medicinal Chemistry- Balkishen Razdan

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry
CHEED 404: PHARMACEUTICAL & INDUSTRIAL PRACTICES

100 Marks **60 Hrs**

Unit I: Various departments in a Pharmaceutical Industry **30 Hrs**

Information about each section-their organization, work carried out, monitoring, interactions with various departments.

Overall idea of each department: Drug discovery, Process development, Pharmaceutical formulation, Production (Bulk drugs & Fine chemicals), Analysis (Intermediates, Finished goods & formulations), Regulatory affairs: (Product protection, Patenting, Regulated-non regulated markets), Packaging: (Designing & Stability), Distribution: (Local & Overseas), Selling: (Local & Overseas), Advertising: (Local & Overseas), Waste disposal: An environment protection

Unit II: Agents for organ imagine OR Diagnostic agents. **15 Hrs**

Introduction, Classification, Radiopagues agents (contrast media), Water soluble and Water insoluble contrast media. Synthesis of Metrizamide, Iopanoic acid and Pyropylidone. Diognostic chemicals: i) Drugs used to test kidney functions, ii) Drugs used to test liver functions, iii) Agents used to test gastric function, iv) Agents used to test cardiac function, v) Miscellaneous diagnostic chemicals.

Unit III: Drug acting on Gastrointestinal tract (Drug acting on GIT) **15 Hrs**

Introduction a) Gastric antacid: i) Treatment of gastric hyperacidity, ii) H2-receptor antagonists-Synthesis of Ranitidine (Zantac) and Famotidine. b) Ulcerative colitis. c) Antispansmodics agents (Spasmolytic agents), d) Anthelmintic agents: Introduction, anthelmintic agents, synthesis of mebendazole.

Reference books

1. Medicinal chemistry (Vol. I and II)-Burger.
2. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
3. Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
4. Medicinal chemistry-William O. Foye
5. T. B. of Organic medicinal and pharmaceutical chemistry-Wilson and Gisvold's (Ed. Robert F. Dorge)

6. An introduction to medicinal chemistry-Graham L. Patrick.
7. An introduction to drug design-S. S. Pandeya and J. R. Dimmock (New age international)
8. Pharmacological basis of therapeutics-Goodman and Gilman's (McGraw Hill)
9. Manual of patent practice and procedure-Patent office, India (2005)

OR

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry

CHEED 404: DRUG REGULATORY AFFAIRS

100 Marks **60 Hours**

UNIT I **12 Hrs**

1.1 Drug Regulatory Aspects (India) -

Indian drug regulatory authorities, Central and State regulatory bodies (State FDA, DCGI, CDSO); Drugs and Cosmetics Act and Rules with latest Amendments (Special emphasis - Schedule M and Y); New Drugs - (Importation, Registration, Development, Clinical Trials, B.E. studies);Various licenses - (Test license, Import license for testing of drugs and API's, Mfg., Contract and Loan license manufacturing.)

1.2 Good Manufacturing Practices (GMP) -Indian GMP certification, WHO GMP certification; ICH guidelines for stability testing and other relevant ones (Q1 - Q10); Export permissions and manufacturing for semi-regulated countries; Understanding of the plant lay-outs with special emphasis on the environment & safety (HVAC, Water systems, Stores management, Effluent etc.); Quality Assurance and Quality Control - Basic understanding for in-built quality.

UNIT II **12 Hrs**

1.3 D rug Regulatory Aspects (International & highly regulated markets) - US Requirements - (for Generic Drugs especially formulations); CDER, INDA, NDA, ANDA's (types), CTD Formats of dossiers, E-submission, US DMF (various types), IIG Limits, Orphan Drugs, Exhibit/Pivotal batches, Validation batches, Various Guidance issued by CDER, OGD, Orange Book (and patents), RLD (Reference listed drug) for BE studies and the norms for US

submission, Bioequivalence and dissolution recommendations, Packaging, Stability studies and the Product Information Leaflet, US FDA Inspection (audits), Pre-approval Inspections and approvals; A brief introduction to the guidelines for Europe, Japan, Australia, South Africa, Rest of the World (ROW) and South & Latin American countries; GMP audits, role of Quality Assurance, product approvals and supplies.

1.4 Introduction to IPR & Patents - Development of IP law in India, IPR regime, Introduction to IP laws in India, Role of IP in Pharma industry growth.

UNIT III **12 Hrs**

1.5 Patenting in India - Introduction, Patent legislation, Indian Patents Act 1970 and amendments, Procedure for patent application, Grant and opposition proceedings, Patent licensing, Patent infringement proceedings, IPAB - Role and functions (IP Appellate Board).

1.6 Patent search, Patent analysis & Patent drafting.

1.7 Allied Patents Related Issues:

1.8 Indian IP case studies- The Novartis case, Lipitor case, Natco versus Bayer case of compulsory license, Patenting and traditional knowledge [Neem, Basmati, Haldi patent], Patenting of life forms [Diamond versus Chakravarty case].

UNIT IV **12 Hrs**

1.9 American & European patent system - Requirements for patenting: utility, novelty, non-obviousness. Patent specification & claims, Patent infringement and Doctrine of Equivalents, Federal circuit and Patent system in Europe 2.0 International treaties and conventions on IPR - Paris convention, PCT - an introduction, PCT application & general rules, WTO / GATT system & Uruguay TRIPS, WIPO, Doha declaration.

UNIT V **12 Hrs**

2.1 Hatch Waxman Act and amendments, FDA Medicare Modernization Act,2003

2.2 Introduction to Geographical indication / Trademark/ copyright: Filing Procedures

Exploitation of patent, Abuse of patents, Compulsory licensing, Infringement analysis, Drug-Patent Linkage

Reference books:

1. CDSO publications and updates of drug and Cosmetics act and rules (Govt. of India).
2. CDER Publications and Guidance
3. EMEA Publications and Guidance
4. Orange Book, ICH guidelines, Indian Patents Act
5. Country specific Regulatory Guidelines (available from internet)
6. Govt. Publications on issues affecting sales, distribution, manufacturing, excise, etc.
7. J. D. Nally, "Good manufacturing Practice for Pharmaceuticals" Informa Healthcare.
8. I. Kanfer & L. Shargel, "Generic Product Development BE issued" Informa Healthcare.
9. R. A. Guarino, "New Drug Approval Process. The Global challenges". Informa Healthcare.
10. Watcher and Nash, "Pharmaceutical Process Validation". Marcel Dekker.
11. Pharmaceutical Product Dev. IVIVC by Murthy, Sunkara and David
12. USPTO and WIPO Guidelines.
13. S. W. Deshpande, Drugs and Cosmetics Act, 1940 and Rules, 1945 and Drugs [Price Control] Order, 1995.

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry

CHELD 405 : RESEARCH LITERATURE & SEMINAR

100 Marks **120 Hours**

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M. Sc. Second Year (*Fourth Semester*) Drug Chemistry

CHELD 406 : RESEARCH PROJECT EXPERIMENTAL

100 Marks **120 Hours**

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M. Sc. Second Year (*Fourth Semester*) Drug Chemistry

CHELD 407 : RESEARCH PROJECT DISSERTATION & PRESENTATION

100 Marks **120 Hours**

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M. Sc. Second Year (*Third Semester*) Analytical Chemistry

CHECA 301: APPLICATION OF MOLECULAR SPECTROSCOPY

100 Marks **60 Hours**

Unit I: General Introduction of Spectral Methods **05 Hrs.**

Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter–absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra, Basic elements of practical spectroscopy, Resolving power, Signal to noise ratio, Uncertainty relation and natural line width, Natural line broadening, Intensity of spectral lines, Energy levels, Selection rules, Components of spectrometer and their functions.

Unit II: Microwave spectroscopy **05 Hrs.**

Rotation of molecules, Rotational spectra, Diatomic molecules–rigid diatomic molecules, Intensities of spectral lines, Effect of isotopic substitution, Non–rigid rotator, The spectrum of non–rigid rotator, Polyatomic molecules, Technique and instrumentation in outline, Applications, Numericals.

Unit III: Vibrational Spectroscopy **15 Hrs.**

A. Infrared spectroscopy – Review of linear harmonic oscillator, The vibrating diatomic molecule, The simple harmonic oscillator, The anharmonic oscillator, The diatomic vibrating rotator, Vibration– rotation spectrum of carbon monoxide, Breakdown of Born–Oppenheimur approximation, The vibration of polyatomic molecules, Overtones and combination frequencies, The influence of rotation of the spectra of polyatomic molecules the influence of nuclear spin, Symmetric top molecules analysis by infra–red technique–Group frequencies, Outline of technique and Instrumentation.

B. Raman spectroscopy –Classical and Quantum of theory of Raman effect, Pure rotational, vibration and vibrational–rotational Raman spectra, Rule of mutual exclusion, Overtone and combination vibrations Rotational fine structure, Outline of technique and instrumentation, Applications.

C. IR & Raman Studies of Complexes

Origin of Molecular Spectra, Origin of Infrared and Raman Spectra, Modes of vibrations, Selection Rules for Infrared and Raman Spectra, Normal modes of vibrations in AB_2 (Linear/Bent), AB_3, AB_4, AB_5, Octahedral AB_6 molecules with factors affecting band frequencies.

Unit IV: X–ray Diffraction **05 Hrs.**

Generation of X–rays, Interaction of X–rays with matter, Bragg's law, Miller indices, Diffraction methods (Laue/Single crystal and Powder/Debye–Scherrer methods), General instrumentation, Factors affecting X–ray intensity calculations, Identification of unit cells from systematic absences, Structure factor and its relation to electron density and intensity, Indexing of lattice planes in cubic system, Structure of NaCl and KCl, Avogadro's number from cubic lattice dimensions, Applications.

Unit V: Electronic Spectroscopy **10Hrs.**

A. Atomic spectroscopy: Energies of atomic orbitals, Vector representation of momenta and vector coupling, Spectra of hydrogen and alkali metal atoms.

B. Molecular spectroscopy: Energy levels, Molecular orbitals, Vibronic coupling, Vibrational progression, Franck–Condon principle, Electronic spectra of polyatomic molecules.

C. Photoelectron spectroscopy: Basic principle, photoelectric effect, ionizatioprocess, Koopman theorem, Instrumentation (Sources for ESCA & AES, Vaccum System, Specimen & its manipulation, Analyzers, Detectors), Satellite peaks, Spectral splitting ESCA, Chemical shifts, PES spectra of simple molecule, Applications, Auger effect (KLL effect).

Unit VI: Mossbauer Spectroscopy **08 Hrs.**

Principle of Mossbauer spectroscopy, Instrumentation, Isomer shift and its factors affecting, Quadrupole splitting, Temperature Dependence of MB parameters, Zeeman Splitting (Six fingered MB lines), MB spectra of iron and tin compounds, Applications, Numerical.

Unit VII: Electron Spin Resonance Spectroscopy **12 Hrs.**

Introduction, Principle of ESR Spectroscopy, Instrumentation, Presentation of spectrum, Hyperfine splitting in some simple systems, Hyperfine splitting in various structure (Naphthalene anion radical, Pyrazine anion radical, Isomers of Xylene anion radicals, VO^{2+}, Quinoline radical, Isoquinoline radical, Quinoxaline radical, Anthracene radical, Phenanthracne radical, Pyrene radical, Alkyl halide radicals, Quinone & Isoquinone anion radicals, nitrogen/deuterium containing radicals), Hyperfine splitting diagram, 'g' value, g-marker, Factors affecting the magnitude of 'g' values, Determination of g-value, Zero field splitting, Karmers's degeneracy, Applications, Numericals.

Reference Books

1. Physical Methods in Chemistry, IInd Edition, R. S. Drago.
2. P.H. Rieger, Electron Spin Resonance: Analysis & Interpretation, RSC Publishing, 2007.
3. B. Simovic, Introduction to the Technique of ESR Spectroscopy. 2004.
4. Lund, M. Siotani, S. Shimada, Principles and Applications of ESR Spectroscopy, Springer.
5. P. Gutlich, E. Bill, A.X. Trautwein, Mossbauer Spectroscopy & Transition Metal Chemistry, Springer Publications, 2011.
6. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A & Part B, John Wiley & Sons Publishers.
7. Mossbauer Spectroscopy: Principles and Applications of the Techniques, A.G. Maddock.
8. An introduction to Electron Paramagnetic Resonance, *M. Bersohn & J.C.Baired,* W.A.Benjamin, Inc N.Y.
9. High resolution ESR Spectroscopy, F.Gerson (John Wiley & sons)
10. The Determination of Molecular Structure, P. J Wheatly
11. Physical Chemistry, G. M. Barrow
12. Instrumental Methods of Chemical Analysis, Chatwal Anand
13. A Text book of Physical Chemistry, A. S. Negi & S.C. Anand
14. Instrumental Methods of Chemical Analysis, Willard, Merritt, Dean & Seatle
15. Instrumental Methods of Chemical Analysis, B. K. Sharma
16. Instrumental Methods of Chemical analysis, R.D. Braun
17. Principles of Instrumental Analysis, Skoog and West
18. Fundamental of Molecular Spectroscopy, Banwell
19. Atomic and Molecular structure, Manas Chanda
20. Molecular Spectroscopy, B. D Acharya
21. Molecular Spectroscopy, Dyer
22. Spectroscopy Methods in Organic Chemistry D. H. Williams and I. Fleming

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

CHECA 302: ENVIRONEMTAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Air Pollution **10 Hrs.**

General consideration, Sources and sinks of air pollutants, Classification of air pollutants, Effect of air pollutants on living and non-living things, Sources and control of air pollution, Air quality standards and Sampling. Analysis of air pollutants (CO, CO_2, NOx, SOx, H_2S, NH_3, Hydrocarbons and particulates). Green house effect, Acid rain, Ozone depletion and their consequences on environment. Effects of air pollution, Photochemical smog and monitoring of air pollution.

Unit II: Water pollution **15 Hrs.**

A. General: Origin of wastewater, Types of water pollutants and their effects, Sources of water pollution: domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Water quality parameters & standards, Sampling methods & prevention, Objective of analysis, Parameters for analysis: colour, turbidity, total solid, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Heavy metal pollution, public health significance of Cadmium, Chromium, Copper, Zinc Lead, Manganese, Mercury and Arsenic.

B. Analysis & Treatment of Waste Water

General survey of instrumental techniques for the analysis of heavy metals in aqueous systems. Oxygen content of water and aquatic life. Measurements of Dissolved oxygen (DO), Biological Oxygen Demand & Chemical oxygen demand and their significance as pollution indicators., Monitoring techniques & methodology with special reference to Ammonia, Chloride, Fluoride, Nitrate, Nitrite, Cyanide, Lead, Cadmium, Mercury. Sewage composition & treatment.

Unit III: A. Chemical Toxicology **10 Hrs**

Toxic chemicals in environment, Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Chromium, Carbon monoxide, Sulphur dioxide, Pesticides.

B. Analysis of Pesticides

Introduction and classification of pesticides

i) Legislation & recent amendments with respect to the pesticides materials

ii) Application dosage of different pesticides

iv) Analysis of DDT, BHC, Gammexane, Endosulphan, Zinab, Ziram, Malathion, Thiram, Thiometon, Simazine and Chloridane.

Analysis of Phosphatic fertilizers for ammonium sulphate, Analysis of Superphosphate, Analysis of water soluble phosphate (or available phosphate).

Analysis of Potassium by Perchlorate method, Cobaltnitrite method and Flame Photometric method.

Unit IV: Industrial pollution

A. Noise Pollution **10 Hrs**

Introduction, Difference between sound & noise pollution, Sources, Noise level measurments, Sonic boom, Anaerobic chamber & Reverberating of sound, Effects & Control.

B. Effluent Analysis

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 Soil and Fertilizer Analysis : **15 Hrs**

Fundamentals, Soil Sampling, Determination of soil moisture (Gravimetric, Electrical Conductivity, Tensitometer), pH determination of Soil (Colorimetric, Potentiometric methods)

Determination of lime & liming materials in soil, Determination of silica and Phosphorus in soil, Determination of total manganese in soil, Determination of soluble salts (alkali salts) in soil. Factors affecting fertility of soil, Analysis of organic content in soil samples include total carbon by Wet method, total nitrogen by Wet & Kjeldahl methods.

Classification of fertilizers (Nitrogeneous, Phosphatic and Potassic fertilizers), Analysis of Nitrogenous fertilizers for ammonium sulphate (titrimetric, Spectrophotometric), Microdetermination of nitrogen (Duma's method), Determination of ammonical and Nitrate nitrogen.

Reference Books

1. A.K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
2. R.K. Trivedi, P.K. Goel, Chemical and Biological Methods for Water Pollution Studies Environmental publication.
3. S.C. Santara, Environmental Science, Central Publications.
4. S.L. Chopra, J.S. Kanwar, Analytical & Agricultaure Chemistry, Kalyani publications.
5. S.M. Khopkar, Environmental Chemistry.
6. V.Subramanim, Environmental Science, Narosa Publishing House.
7. E. Bhatucha, Environmental Studies, UGC Press.
8. D.E. Newton, Chemistry of the Environment, Infobase Publishing-New York, 2007.
9. S.E. Manahan, Environmental Chemistry, Lewis Publishers.
10. A. Sharma & A. Kaur, Environmental Chemistry, Krishna publishers.
11. S.M. Khopkar, Environmental Pollution Analysis, Wiley Eastern Ltd. New Delhi.
12. Environmental Toxicology, Eds. J. Rose, Gordon and Breach Science Publications.
13. Atmospheric Pollution, W. Buch, McGraw Hill, New York.
14. Fundamentals of Air Pollution, S.J. Williason, Addison–Wesley Publishers.
14. Analytical Aspect of Environmental Chemistry, D.F.S. Natush and P.K. Hopke
15. J.W. Vanloon, Environmental Chemistry, Oxford University Press.
16. B. Pani, Environmental Chemistry
17. B. Ghosh, M.S. Ranganathan, S. Sridhar, Enzyme and Food Biotechnology, Wisdom Press.
18. M. Pansu, J. Gautheyrou, Handbook of Soil Analysis (Mineralogical, Organic and Inorganic Methods), Springer Publications, 2010.
19. B.K. Sharma, Analytical Chemistry.
20. Chopra and Kanwar, Analytical Agriculture Chemistry, Kalyani Publications.

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

CHECA 303 : ORGANIC REACTIONS AND REARRANGEMENTS

100 Marks **60 Hours**

Unit I : Organic Reactions **15 Hrs**

Reaction, Mechanism and applications of following reactions: Gabriel synthesis, Streker amino acid synthesis, Ullmann, Mitsnobu, Favorski, Hofmann-Loffler-Freytag, Shapiro, Dakin, Von Richter, Henery, Mukaiyama reaction, Sonogishira reaction.

Unit II: Organic Rearrangements **15 Hrs**

Introduction

(A) Migration to Electron deficient Carbon: i) Pinacol-Pinacolone, ii) Wagner-Meerwein, iii) Demjanov, iv) Wolf, v) Benzil-Benzilic acid rearrangement.

(B) Migration to Electron deficient Nitrogen: i) Beckmann, ii) Hoffmann, iii)Curtius, iv) Lossen, v) Schimidt rearrangement.

(C) Migration to Electron deficient Oxygen: i) Favorskii, ii) Neber, iii) Dakin rearrangement.

(D) Electrophilic Rearrangement: i) Stevens, ii) Wittig, iii) Smile rearrangement.

Unit III: Pericyclic Reactions **15 Hrs**

Introduction, Classification, Molecular Orbital Conservation Approach

(A) Cycloaddition reaction: Cycloaddition reactions and their stereochemical aspects, Woodward-Haffman rule, Selection rule for cycloaddition reaction, Details with examples of Diels-Alder reaction, (2+2) cycloaddition, (1, 3) polar cycloaddition, Cycloaddition of alkenes with OsO_4 and ozone, Cheleotropic reactions, Analyses of cycloaddition by FMO, Mobius-Huckel and Corrlaion diagram methods.

(B) Electrocyclic Reaction: Electrocyclic reactions and their stereochemical aspects, Selection rule of electrocyclic reaction, Con-rotations and dis-rotations, Methods of analyses of the electrocyclic reactions: FMO, Mobius-Huckel and Correlation diagram approaches.

(C) Sigmatropic rearrangements: Sigmatropic rearrangements and their stereochemistry, Rules for Sigmatropic rearrangements, Examples on (1, 3), (1, 5), (1, 7), (3, 3), (2, 3) Sigmatropic shifts, Claisen, Cope, Oxy-cope, Aza-cope, Sommelet-Hauser rearrangements, Ene reaction, Methods of analyses of the rearrangements: FMO, Mobius-Huckel and Correlation diagram approaches.

Unit IV: Photochemical Reaction **10 Hrs**

(A) Photochemistry of Alkenes: Intermolecular reactions of the Olefinic Bond-Geometrical Isomerism, Cyclization reactions, Rearrangement of 1, 4- and 1, 5-dienes.

(B) Photochemistry of Carbonyl compounds: Intermolecular reactions of the Carbonyl compounds-saturated, Cyclic and acyclic, β, γ-gamma unsaturated and α, β-unsaturated compounds, Cyclohexadienones, Intermolecular Cycloaddition reactions, Dimerizations and Oxetane formation.

(C) Photochemistry of Aromatic Compounds: Isomerization, Additions and Substitutions.

Unit V: Protecting Groups **5 Hrs**

Introduction, Principle, Protecting groups for alcohols, carbonyl, carboxylic acids, amino groups.

Reference Books:

1. Designing Organic Synthesis: S. Warren, Wiley.
2. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers
3. Protective Groups in Organic Synthesis: T. W. Greene, G. M. Wuts.
4. Organic Syntheis: Jagdama Singh and L. D. S. Yadav
5. Advanced organic Chemistry: Part A & B, Reactions and Synthesis, F. A. Carey and R. J. Sundberg.
6. Organic Synthesis: M. B. Smith.
7. Principle of organic synthesis: Norman and Coxon
8. Advanced organic chemistry: Jerry March
9. Organic Photochemistry: Robert Kan

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

CHEEA 304: ANALYTICAL METHODS IN CHEMICAL ANALYSIS

100 Marks **60 Hours**

Unit I Atomic Absorption & Flame Emission Spectroscopy **15 Hr**

Flame Emission Spectroscopy: Elementary theory of flame photometry, Instrumentation and experimental techniques. Interferences & Methods for their Overcoming, Types of FES and Applications.

Atomic absorption spectrometry (AAS): Introduction, Principles, Advantages of AAS over FES, Instrumentation, Flame & Non-flame atomization. Sources of AAS (EDL, TGL, HCL), Interferences and Applications, Comparison of atomic absorption with flame emission spectroscopy, Numericals.

Unit II Thermal Analysis **10Hr**

General introduction, Classification of thermal methods of analysis,

Thermogravimetric analysis: Principles, Thermobalance, Factors affecting thermal curve, Derivative thermogravimetric analysis, Applications TGA for quantitative analysis (TG analysis of $CaC_2O_4H_2O$, $CuSo_45H_2O$, dolomite ore etc.)

Differential thermal analysis: Principles, Instrumentation, Factors affecting DTA curve, Applications (DT analysis of sulfur, $CuSo_45H_2O$, mixture of polymer, $CaC_2O_4H_2O$)

Differential scanning calorimerty: Principles, DSC vs DTA, Instrumentation, Applications (DCS curve of polyethylene terphthalate, DSC curve for isothermal crystallization of polyethylene, DSC of phenacetein), Thermometric titrations, Numericals.

Unit III: **15Hr**

(a) Fluorescence and phosphorescence Spectrophotometer

Difference between delayed fluoresesence and phosphorescence, Quenching of fluorescence, Formation of excimer and examples. Structural factors, Phosphorescence intensity as related to concentration, Instrumentation for fluorescence and phosphorescence measurements, Problems.

(b) Coulometry Introduction, Principle, Techniques, Coulometer at constant & controlled current and Potential Coulometer, Primary & Secondary coulometric titrations, Errors in coulometric titrations, and Applications.

(c) Chemical & Bio- Sensors

Introduction, Sensor Design, Detection Methods, Sensing Principle of sensors, Various Chemical sensors include Oxygen gas sensors, pH sensors, Acidic/basic gas sensors using pH sensitive dyes, Cationic sensors, Anionic sensors, Biosensors.

Unit IV: (a) Polarography and Cyclic Voltametry. **20 Hrs.**

Introduction, Theory (include Ilkovic equation, Reversible & Irreversible electrode processes, Reversible polarographic waves), Instrumentation(DME, HDME), Modified Polarography techniques (include Sinusoidal AC Polarography, Square wave polarography, Oscillographic polarography, Rapid scan Polarography), Pulse Polarography, Chronopotentiometry & its practical aspects, Applications in qualitative and quantitative analysis,

Principle of cyclic voltammetry, Instrumentation, cyclic voltamogram of $K_3[Fe(CN)_6]$, criteria of reversibility of electrochemical reaction , quasi reversible and irreversible process.

(b) Ion Selective Electrodes: Terminology, Types and construction of electrodes, Glass electrode, Solid state and Precipitate electrode, Liquid-liquid membrane electrodes, Enzyme & Gas electrodes, Applications.

(c) Electrogravimetry and Electrophoresis

Electrogravimetry: Introduction, type of electrogravimetry , term used in electro-gravimetric analysis, completeness of deposition, electro-analytical separation of metal , application.

Electrophoresis :Introduction, Paper electrophoresis and its advantages with limitations, Techniques in paper electrophoresis, Calculation of electrophoretic mobility, Factors affecting migration of the ions, Continuous electrophoresis, Thin layer electrophoresis, Density gradient electrophoresis, Zone electrophoresis, Curtain electrophoresis, Reverse Osmosis, Electrodialysis, Capillary electrophoresis or Capillary zone electrophoresis & its applications, Applications of paper electrophoresis.

Reference Books

1. D.K. Gosser (Jr.), Cyclic Voltammetry: Simulation and Analysis of Reaction Mechanisms, VCH Publishers, 1994.
2. K. Zutshi, Introduction to Polarography and Allied Techniques, New Age Publications, 2006.
3. Comprehensive Analytical Chemistry, Eds. D. Barcelo, Elsevier Publications, 2006.
4. Modern Instrumental Analysis, Volume 47. Eds. S. Ahuja, N. Jespersen, Elsevier Publications, 2006.
5. Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, John Wiley & Sons, 1989.
6. A.J. Bard, L.R. Faulkner, Electrochemical Methods: Fundamentals and Applications, John Wiley & Sons.
7. Fundamentals of Photochemistry, Rohatgi – Mukherjee.
8. Photochemistry, J.G.Calvert and J.N.Pitts.
9. Photo–luminescence of solutions, C.A. Parrker
10. Photochemistry, A. Singh and R. Singh
11. F.J. Welcher, Standards Methods of Chemical Analysis
12. Quantitative Analysis, 6th Eds., R.A. Day Jr., A.L. Underwood
13. Fundamental of Analytical Chemistry, 8th Eds., D.A. Skoog, D.M. West, F.J. Holler, S.R. Crough.
14. Analytical Chemistry, 6th Eds. G D. Christian.
15. Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.O. Barnes, M. Thomas, B. Sivasankar.
16. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt Jr., J.A. Dean, F.A. Settle Jr.
17. Basic Concepts in Analytical Chemistry, S.M. Khopkar,
18. Quantitative Analytical Chemistry, 2nd Eds. James S Fritz and George H. Schenk Jr.
19. Handbook of Instrumental Methods for Analytical Chemistry, F. Settle.
20. Treatise on Analytical Chemistry: Vol. I to Vol. II–I .M. Kolthoff.
21. Modern Instrumental Analysis, Volume 47. Edited by S. Ahuja, N. Jespersen, Elsevier
22. Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, John Wiley & Sons, 1989

OR

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

CHEEA 304: ADVANCED ANALYTICAL TECHNIQUES- I

100 Marks **60 Hours**

Unit-I Molecular Luminescence Spectrometry: **10Hr**

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

Unit-II Surface Characterization by Spectroscopy and Microscopy: **12Hr**

Introduction to the study of surfaces, Spectroscopic surface methods, Ion spectroscopic techniques, Surface photons spectroscopic methods, Electron stimulated microanalysis methods, Scanning probe microscopes

Unit-III **12Hr**

a) Properties of Supercritical Fluids, Supercritical Fluid Chromatography, Supercritical Fluid Extraction.

b) Principle, Instrumentation and Applicationof the followings-

High performance thin layer chromatography, Ultra performance liquid chromatography, Advancedflash chromatography

Unit-IV **12Hr**

a) Radioactive Nuclides, Instrumentation, Neutron activation methods, Isotope dilution methods

b) Atomic X-ray spectrometry- Fundamental principles, Instrument components, X-ray fluorescence methods, X-ray absorption methods

Unit-V **12Hr**

a) Introduction, Need for hyphenation, Possible hyphenation, Interfacing devices and applications of the following: LC-MS, GC-IR, GC-MS,ICP-MS, MS-MS.

b) Principle of automation, Flow – injection Analysis, Microfluidics, Discrete automatic systems

Reference Books

a) Instrumental Methods of Analysis–Willard, Merritt, Dean & Settle.

b) Instrumental Analysis- Skoog, Holler, Crouch.

c) Principles of Instrumental Analysis–Skoog, F.J.Holler&J.A.Nieman

d) Instrumental Methods of Chemical Analysis–Galen W. Ewing.

e) Analytical Chemistry – Gary D. Christian, 6th edition

f) Handbook of Instrumental Techniques for Analytical Chemistry –Frank Settle,Editor

g) Introduction to Instrumental Analysis-R.D. Braun, McGraw Hill.

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

CHELA 305 : LABORATORY COURSE V

(PART A: ANALYTICAL CHEMISTRY PRACTICAL-I & PART B: ANALYTICAL CHEMISTRY PRACTICAL-II)

100 Marks **120 Hours**

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PART A: ANALYTICAL CHEMISTRY PRACTICAL-I **(50 Marks)**

PART B: ANALYTICAL CHEMISTRY PRACTICAL-II **(50 Marks)**

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

CHELA 306 : LABORATORY COURSE–VI

(PART A: Organic Spectral interpretation & PART B: Analytical Spectral interpretation)

100 Marks **120 Hours**

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PART A: Organic Spectral interpretation **(50 Marks)**

1. UV-Visible
2. ^{1}H NMR
3. ^{13}C NMR

4. Mass Spectroscopic

PART B: Analytical Spectral interpretation **(50 Marks)**

1. XRD
2. Mossbauer Method
3. ESR
4. Polarographic methods

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

CHECA 401: APPLIED ANALYTICAL CHEMISTRY-I

(Ores, Alloys, Explosive and Cosmetic)

100 Marks **60 Hours**

Unit I: (a) Analysis of Ores and Alloys **12Hrs.**

Constituents and Analysis of the following ores: Iron ore for total iron by volumetric and gravimetric method (Hematite), Manganese ore for total Manganese by gravimetric & volumetric method Pyrolusite), Chromium ore for chromium by volumetric and gravimetric method (Chromite), Aluminium ore for aluminium by volumetric method (Bauxite), Titanium ore for titanium by volumetric and colorimetric method (Ilemenite), Monazite ore for thorium & its oxides, Copper ores (Malachite Green), Dolomite, Galena ores.

Analysis of Alloys Analysis of major & minor components of the following Alloys: Brass, Bronze, Monel-Metal, Types-metal, Solder, Silver-coin, Steel, Stainless steel

Unit II: **12Hrs.**

(a)Analysis of Cement and buildingmaterials.: Types of cement, Sampling, Analysis of- Silicon dioxide, Aluminum oxides, Ferric oxides, Calcium oxide, Magnesium oxide, Sodium and potassium oxide.

(b) Analysis of Glass: Types of glasses, Determination of lead and lead glass.

(c) Explosive :Explosion, Detonation, Classification of explosives, Propellant, Fulminates, Detonators, lasting-cap, Thermochemistry, Hygroscopicity of explosives, Moisture by Karl-Fisher titration, Isolation from debris, Qualitative test,Cation& anion analysis by capillary electrophoresis, EDXRF, Analysis by TLC,HPLC, IR,GC-TEA method.

Unit III: **12Hrs.**

(A) Fuels:

Introduction, calorific value.Determination of calorific value.Modern concept of fuels. Classifications of fuels ,criterion of selection of fuels , properties of fuels. Method of processing. Solids fuels ,Natural solid fuels, Artificial solid fuels ,Industrial solids fuels .Formation of coal properties of coal ,Classification of coal., coking and non-coking coals. pulverised coal. .Role of sulphur and ash in coal ,approximate analysis ,Ultimate analysis. Numerical.

(B) Petroleum:

Occurrence, mining of petroleum. Prospecting colour and consistency. Origin composition, classification terms related to petroleum. .Distillation of crude petroleum.Treatment of the residual liquid, Determination of flash point. Determination of aniline point .Knocking and Anti-knocking compounds. Octane number. Cetanenumber,Numericals

Unit IV: (a) Analysis of Paints & Pigments **12Hrs.**

Introduction, Determination of non-volatile & volatile components, Flash points, Separation, Isolation & Determination of pigments and thinners of solvent types coating, Types of Pigments, Isolation & Determinations of binders (IP method).

(b) Analysis of Soap & Detergents: Soap: Introduction, Types of soap, Manufacturing steps of soap (such as Boiling, Graining/Salting out, finishing), Cleansing action of soap.

Detergents: Introduction, Raw materials for detergents, Types of Detergents, Comparision of cleansing action between soaps and detergents.

Unit V: Cosmetic Analysis: **12 Hr**

(a) Cosmetic : Introduction, Evaluation of cosmetic material and raw material and additive . formulation, standard and methods of analysis

(b) **Deodorants and antiperspirants** : Al, Zn, Zr, Boric acid, chloride , sulphate, hexachlorophene, ethanamine , phenolsulphonates and urea.

(c) **Face powder** : Fats, fatty acid, boric acid, Ca. Mg,BaSO4, Ti, Fe, Oxides of TL, Fe and Al

(b) **Hair tonic** : Hair tonic: 2,5-diaminotoluene, potassium bromates, sodium perborate,pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers)

(c) **Creams and lotions** : types of emulsions, chloroform soluble material, glycerol, pH emulsion, ash analysis, non volatile matter by IR spectroscopy.

(d) **Lipsticks**: General analysis, determination of nonvolatile matter, ash analysis determination of lakes and fillers, trichloroethylene – acetone soluble contents.

References Books

1. S.K. Jain, Introduction to Metallurgical Analysis: Chemical Analysis and Instrumental.
2. F.J. Welcher, Standards Methods of Chemical Analysis.
3. Harry's Cosmetology, Longman scientific co.
4. Formulation and Function of cosmetics, Sa Jellineck.
5. Cosmetic Technology, Saggarin
6. Modern cosmetics, E. Thomessen Wiley Inter science
7. Hillenbrand Lhundel, Bright and Hoffman, Applied inorganic analysis, John Wiley.
8. Snell and Biffen, Commercial methods of analysis.
9. P. G. Jeffery, Chemical methods of rock analysis, pergamon.
10. Rieche, Outline of industrial organic chemistry, Butter worth.
11. Kent, Rieg's Industrial chemistry, Rain hold
12. P. G. Jeffery and. J. Hatchinsion, Chemical methods of rock analysis.
13. F. J. Welcher Standard methods of chemical analysis, A series of volume Robert and Krigeger Publishing Company.
14. Metallurgical analysis by S. K. Jain and K. K. Jain.
15. www.dghs.gov.in

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

CHECA 402: APPLIED ANALYTICAL CHEMISTRY II

(Food, Oils & Fats)

100 Marks **60 Hours**

Unit I: (A) General Concepts of Food Analysis **15 Hrs.**

i) Food contamination & spoilage: Causes, Microbial spoilage of fish, Bacterial spoilage of meat & its products, spoilage of milk & its products

ii) Food safety considerations. Appearance, Texture, Flavor

iii) Legislation related to food & recent amendments

(B) Methods of Food Analysis

i) Food sampling for analysis

ii) Proximate composition of food: Water, Ash mineral matter, Nitrogen & crude nitrogen, Carbohydrates, Lipids/Fats, Proteins.

iii) Chemical characteristics & constituents.

Unit II Analysis of Food Additives **15Hrs.**

i) Food Preservatives: Definition, Preservation methods (Temperature control, Moisture control), Organic/Inorganic Chemicals as a preservatives (Benzoic acid, Sorbic Acid, Parabens, Sulfites, Nitrates, Nitrites, Sodium Chloride, Hydrogen Peroxides)

ii) Food Emulsifiers: Algin, Alginates in foods, Detection of alginates in foods

iii) Food Adulterants: Definition, Adulteration of juice, soft drinks, milk.

iv) Food stabilizers: Definition, Extraction of gum from fruits and vegetable products.

v) Sweetners: Definition, Different artificial sweeteners (Saccharin, Aspertame, Cyclamate, Dulcin, Acesulfame-K, Sucralose)

Unit III: Oil and Fat Analysis in Food **15 Hrs.**

A) Introduction, General Classification of lipids (natural fats & oils) Components of Fats and Oils, Structure of triglycerides, Smoke point, Flash point, Fire point, Cloud point, Acid Value, Saponification Value, Iodine Value, Peroxide Value, Unsaponifiable matter, Water Content, Phosphorus Content, Colorimetric Value, Hexane in extraction meal, Crude Fibre in meal, Protein in meal, Ash, Solid Fat content, Dilatation (Solid fat Index).

B) Analysis :, Solvent extraction methods (Continuous, Semicontinu- ous, Discountious), Nonsolvent Wet extraction methods.

Unit IV: (A)Protein Analysis in Food **15 Hrs.**

Introduction, Analysis by Dumas method, Biuret method, Lowry method, Dye-binding method, Bicinchonic method

(B) Carbohydrate Analysis in Food

Introduction, Analysis of total Carbohydrates by Phenol-Sulfuric acid method, Total Reducing Sugar by Somogyi-Nelson method, Analysis of Total Starch.

(C) Vitamin Analysis in Food

Importance of Analysis, Vitamin Units, Methods for Vitamin Assay (Bioassay, Microbiological assay, Physicochemical assay). Analysis of the following Vitamins: Vitamin A, Vitamin E (Toropherols and Torotrienols), Vitamin C by titrimetric and microfluorometric methods, Vitamin B_1 by thiochrome fluorometric method, Vitamin B_2 by fluorometric method.

References Books

1. S. Suzanne Nielsen, Food Analysis, Springer Publications, 2009.
2. Handbook of Food Analytical Chemistry, Eds. By R.E. Wrostad, T.E. Acree, E.A. Decker, M.H. Penner, D.S. Reid, S.J. Schwartz, C.F. Shoemaker, D. Smith, P. Sporns, Wiley-Interscience Publs.
3. L. Amsel, L. Hirsch, Food Science and Security, Nova Science Publishers, 2009.
4. J.M. deMan, Principles of Food Chemistry, ASPEN Publications, 1999.
5. K.V. Ramesh, Food Microbiology, MJP Publishers.
6. S.N. Mahindru, Food Science and Technology, APH Publishing Corporation.
8. M. Bennion, Introductory Foods, Prentice Hall, Inc.
9. M. Bockisch, Fats and Oils Handbooks, AOCS Publications, 1998.

S. Suzanne Nielsen, Food Analysis, Springer Publications, 2009.

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

CHECA 403: APPLIED ANALYTICAL CHEMISTRY III

(Nanomaterials, Polymers and Catalysis)

100 Marks **60 Hours**

Unit I: Chemistry of Nanomaterials — 25 Hrs.

a) General Introduction, Historical background

b) Synthesis

Chemical Methods include Reduction method for Metal Nanoparticles, Solvothermal method, Photochemical Synthesis, Electrochemical Synthesis, Arrested Precipitation, Sol-gel, Langmuir-Blodgett, Micelles-Microemulsions.

c) Characterization Techniques

Electron Microscopy (TEM & SEM), Probe Microscopy (STM & AFM), Diffraction Techniques (XRD & NRD), UV-Visible-NIR spectroscopy.

d) Properties of Nanoparticles

Mechanical, Optical, Magnetic, Electronic properties

e) Examples of Nanomaterials

Carbon nanostructures include Carbon Nanotubes and graphene, Mesoporous materials include Metal oxides (Titania and ZnO) and Zeolites, Carbon-based Composites, Smart materials.

f) Applications

Electronics, Energy, Automobiles, Sports & toys, Textile, Cosmetics, Domestic appliances, Sensors, Biotechnology & medical field, Space & Defence, Catalysis, Nanotechnology & environment

Unit II: Polymer Chemistry — 20 Hrs.

i) Introduction (Monomer, Co-monomer, Mesomer, Homopolymer, Hetropolymer, Co-polymer)

ii) Classification of polymers, Different types of polymerizations (Condensation polymerization, Addition polymerization-Cationic/Ionic/Free radical/Co-ordination, Chain polymerization, Coordination polymerization, Ring opening polymerization, Group transfer polymerization) & their mechanism, Chain transfer reaction, Ionic copolymerization.

iii) Molecular weight of polymers and their determination by end group analysis, Osmometric, Viscometric, Light Scattering & Sedimentation method.

iv) Synthesis, Properties & Applications of following Polymers:

Polyethylene, polypropylene, polystyrene, polyvinyl chloride, polyacruly nitride, polyester, polyethylene glycols, polyvinyl alcohol, polyetraflueroethylen, silicone polymer, urea-formaldehyde resin, polyurethanes, epoxy resins.

Unit III: Catalysis **15 Hrs**

Introduction, Catalyst and its types, General features of Catalysts (Catalytic efficiency, Catalytic cycles, Selectivity, Energetic, Life time).

Homogeneous Catalysis:

Various catalytic steps (Ligand co-ordination & dissociation, Insertion & elimination, Nucleophilic attack of co-ordinated ligands, Oxidation & reduction, Oxidative addition & reductive elimination), Illustrative examples include Hydrogenation of alkene, hydroformylation of alkenes, Oxidation of alkenes (Wacker process), Carbonylation of methanol to acetic acid (Monsanto process).

Heterogeneous Catalysis:

Nature of heterogeneous catalysts (Surface area, Porosity, Surface acidic and basic sites, Surface metal sites), Various catalytic steps such as chemisorption and desorption surface migration, Illustrative examples include hydrogenation of alkene, Ammonia synthesis, SO_2 oxidation, Interconversion of aromatic Zeolites, Photocatalysis by TiO_2.

Reference Books

1. G.B. Sergeev, Nanochemistry, Elsevier Publications, 2006.

2. Nanomaterials Chemistry: Recent Developments and New Directions, Edited by C.N.R. Rao, A. Muller and A.K. Cheetam, Wiley-VCH, 2007.

3. C.N.R. Rao, P.J. Thomas, G.U. Kulkarni, Nanocrystals: Synthesis, Properties and Applications, Springer-Verlag Berlin Heidelberg, 2007.

4. Nanoparticles: From Theory to Applications, Edited By G. Schmid, Wiley-VCH, 2010.

5. G. Cao, C. J. Brinker Annual Review of Nano Research, Vol.1, World Scientific Publishing.

7. V.R.Gowarikar, N. V. Vishwanathan & J. Sreedhar, Polymer Science, Wiley Eastern.

8. D.D. Deshpande, Physical Chemistry Polymers, Tata McGraw Hill.

9. P.J. Flory, Principles of Physical Chemistry, Cornell University Press.

10. R.B. Seymour, Introduction to Polymer Chemistry by McGraw Hill.

11. E.K. Ridder & H.S.Taylor Catalysis: Theory and Practices.

12.Green chemistry and catalyst, R. A. Sheldon, Isabella Arends, Ulf Hanefeld Wiley VCH verlag GmBH & co.

13. Sustainable residential development: planning and design for green neighborhoods. Avi Friedman, McGraw Hill professional

14.Text Book of polymer science By F.W.Billmeyer, New York: Wiley

15.Physical polymer science by L.H .Sperling wiley –Interscience New York
16.Fundamentals of polymer science & Engineering By A Kumar &S.K.Gupta,Tatamcgraw Hill
17.Introduction to polymer science ,V.R.Gowarnikar, N.V.Vishwanathan& J.
18.Industrial Chemistry, B. K. Sharma, Goel publishing House Meerut.
19.Kent, Rieg's Industrial chemistry, Rain hold.
20.Handbook of Instrumental Techniques for analytical chemistry. Frank Settle, editor 1st Indian print 2004.
21.Polymer science by Vasant Govarikar, Wiley Earstewen. New York.
22.Principle of polymer science, Behadhar and Sastri, Narosa Publishing house.

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

CHEEA 404 : PHARMACEUTICAL, CLINICAL AND FORENSIC ANALYSIS

100 Marks **60 Hours**

Unit I: Quality Assurance **12 Hrs.**

i) Basic terminology: Quality, QA, QC, Good laboratory practices (GLP) and Good Manufacturing practices (GMP)

ii) Pharmacopeia standards: BP, IP, USP, NF, EP.

iii) Different Drug Regulatory Authorities: FDA, NIBSC, TGA, MCC

iv) Drug Development and Regulatory Process: Introduction, Identification of New Molecules, Preclinical Research, Formulation & Development, Regulatory issues, Clinical trials, New Drug Applications.

v) Official method of analysis: Sources of impurities in pharma/food products, Limit test of As, Pb, Fe, Cl, SO_4, Stability studies.

vi) Concept of online analysis: Raw material, Documentation, Finished product, Record keeping

Unit II: Microbiological Analysis **12 Hrs.**

i) Introduction to micro-organism: Bactria, Fungus.

ii)Isolation & identification of important group of Bactria by plate count method.

iii) Determination of cell mass by direct & indirect method.

iv) Microbial growth & Factor affecting it : Temperature, pH, Media & Humidity

v)Counting techniques:

Sterilization: definition, various methods (Chemical/thermal/Radiation)

Disinfection: definition & various methods, Evaluation of antimicrobial agent & disinfects

Aseptic condition & Sterling test (HEPA filter).

vi) Microbiological test for Antibiotics standard preparation and unit of activity, test organism and Inoculums, Cylindrical-plate assay receptacles , Turbidimetric assay receptacles, assay designs, Cylinder plate or Cup plate method, plate count method, test for sterility. Pyrogen Test.

Unit III: Clinical Analysis and Blood Gas Analysis **12 Hrs.**

(a) Clinical Analysis

i) Introduction of blood : Composition, collection & Preservation of blood samples

ii) Analysis of blood sample for the followings :Glucose (Follin-Wu method), Urea (Diacetyl monoxime method & modified Diacetyl monoxime thiosemicarboxime method), Blood urea nitrogen, Serum uric acid, Total Proteins (Albumin ,Globulin, & A.G. Ratio), Biuret method,

specific gravity method, Serum Barbiturates, Spectroscopic method, Serum alkaline phosphate

Serum acid phosphate

(b) Blood Gas Analysis

I. Introduction
II. Processes of obtaining arterial blood sample
III. Blood gas symbols
IV. Blood gas instrumentation
V. Arterial blood gases
VI. Determination of Partial pressure of CO_2 (P CO_2), Oxygen saturation (SO_2), Oxygen contents (O_2), Partial Pressure Of Oxygen (PO_2), CO_2 contents Or total CO_2 contents, Blood p^H

Unit IV: Forensic Analysis **12 Hrs.**

(a)Vegetable drugs analysis: Sampling , foreign organic matter, ash value , acid soluble ash, acid insoluble ash, sulphated ash, extraction of alkaloids.

(b) Sources of Impurities in pharmaceutical raw material and finishing product:

Raw material , Method of manufacture , atmospheric contaminations, cross contamination, microbial contamination, container contamination, packing error, chemical instability, temperature effect and physical changes , self life pharmaceutical product and its determination.

(c) Forensic analysis:

Special features for forensic analysis, Sampling, Sample storage, Sample dissolution, Classification of poisons, Lethal dose, Significance of LD50 & LC50

Toxicology: Isolation, Identification and determination of followings

Narcotics: Heroin, Morphine

Stimulants: Caffeine, cocaine, Amphetamines

Depressant: Barbiturates, Benzodiazepine pines.

Unit V: Drug Analysis **12Hrs**

Classification of drug , classification according to effect methods of screening and investigating the drugs , chemical methods, complexometric method of titration, acid base titration in non aqueous media, express analysis , physicochemical methods , optical methods , refractometry , polarimetry , fluorimetry, some determinations by fluorimetry , spectrophotometry , electrochemical methods , potentiometry, polarography , chromatographic methods , thin layer chromatography, separation of vitamins by thin layer chromatography. Paper chromatography, separation of amino acid by paper chromatography, ion exchange chromatography, gas chromatography, separation of amino acid by gas chromatography , high performance liquid chromatography (HPLC), biological method , radioimmunoassay (RAI) methods.

Reference Books

1. P. Konieczka, J. Namiesnik, Quality Assurance and Quality Control in the Analytical Chemical Laboratory, CRC Press, 2009.
2. Quality Assurance of Pharmaceuticals, WHO, 2007.
3. B.W. Wenclawiak, M. Koch, E. Hadjicostas, Quality Assurance in Analytical Chemistry, Springer Publications, 2010.
4. J.B. Crippin, Explosive and Chemical Weapons Identification, Taylor & Francis Publications, 2006.
5. M.M. Houck, Forensic Science: Modern Methods of Solving Crime, Library of Congress Publications, 2007.
6. A. Mozayani, C. Noziglia, The Forensic Laboratory Handbook Procedures and Practice, Springer-Humana Press, 2011.

7. S. Suzanne Nielsen, Food Analysis, Springer Publications, 2009.
8. Indian pharmacopeia Volume I and II
9. Practical pharmaceutical chemistry third edition value 1
10. By A. H. Beckett and J.B. Stenlake
11. Remington's Pharmaceutical Sciences.
12. Ansels Pharmacetical Analysis.

OR

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

CHEEA 404 : ADVANCE ANALYTICAL TECHNIQUE II

100 Marks **60 Hours**

Unit I: Radiochemical Methods **12 Hrs.**

Elementary working, Principles of Geiger Muller, Ionization, proportional and l-ray counters. Radiotracer techniques, Application of radiotracers in analytical Chemistry.

Neutron activation analysis (NAA): Principle, technique and applications in preparation of some commonly used radioactive isotopes. Isotopic Dilution Analysis (IDA), Substoichiometric IDA, Experimental technique and applications of IDA, Advantages and limitations of IDA and comparison of IDA with NAA. Principle of Radiometric titrations, Types, Experimental techniques and its applications. Carbon dating. Numericals.

Unit II: Online Analyzers **12 Hrs.**

Introduction, Classification of automated methods, Principles and techniques of auto-analyzers employed for microanalysis with emphasis on the basis sequences in operational modes in segmented and non-segmented flow and applications. Selection of online analyzers.

Flow Injection Analysis: Introduction, Principal, theoretical aspects of FIA, Techniques, Pretreatment of sample in packed reactions, Components of FIA apparatus, Factors affecting FIA and applications for the determination F^-, Cl^-, PO_4^{-3}, NO^-_2, NO_3^-, SO_4^{2-},BO_3^{3-}, Ca^{2+}, Mg^{2+}, Al^{3+}, Mn^{2+}, Cr^{6+}, Fe^{3+} in water.

Unit III: Atomic Emission spectroscopy **12Hrs.**

Introduction, Arc and spark atomization, spectra from higher energy sources, emission spectroscopy based upon plasma sources, atomic fluorescence method based upon plasma atomization. Emission spectroscopy based upon arc and spark sources. X-ray fluorescence and its principle.

Unit IV: Neutron & Electron diffraction **12 Hrs.**

Neutron Diffraction: Introduction, NRD vs. XRD, Instrumentation, Magnetic Scattering, Applications.

Electron Diffraction: Scattering intensity Vs scattering angle, Wierl equation, Measurment techniques, Elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surface.

Unit V: Optical Rotatory Dispersion (ORD) and circular Dichroism (CD) **12 Hrs.**

Definition, cotton effect, deduction of absolute configuration, octant rule for ketones.

M. Sc. Second Year (*Fourth Semester*)

CHELA 405 : RESEARCH LITERATURE & SEMINAR

100 Marks **120 Hours**

M. Sc. Second Year (*Fourth Semester*)

CHELA 406 : RESEARCH PROJECT EXPERIMENTAL

100 Marks **120 Hours**

M. Sc. Second Year (*Fourth Semester*)

CHELA 407 : RESEARCH PROJECT DISSERTATION & PRESENTATION

100 Marks **120 Hours**