SYLLABUS

OF

M.Sc. Instrumentation and Commercial Methods of Industrial Analysis

(2020-2022)

DEPARTMENT OF ENVIRONMENTAL CHEMISTRY,

JIWAJI UNIVERSITY, GWALIOR

JIWAJI UNIVERSITY

M.Sc. Instrumentation & Commercial Methods of Industrial Analysis

Choice Based Credit System

Course Structure, Scheme of Examination & Syllabus

2020-2022

SEMESTER I

Code	Title of Course	Total Marks	Total Credits	End Sem. Exam Marks		Sessional Marks	
				Max	Min	Max	Min
ICA-101	Fundamentals of Quantitative Analysis and Separation Methods	100	3	60	21	40	14
ICA-102	Stereo-chemistry &Thermo-analytical Methods	100	3	60	21	40	14
ICA-103	Spectro-analytical Methods of Analysis – I	100	3	60	21	40	14
ICA-104	Electro-analytical Methods of Analysis	100	3	60	21	40	14
ICA-105	Laboratory-I	100	3	60	21	40	14
ICA-106	Laboratory-II	100	3	60	21	40	14
ICA-107	Seminar	100	1	100	35	xx	xx
ICA-108	Assignment (Yoga, Physical Education /Language/Social Work/Environment))	100	1	100	35	xx	xx
ICA-109	Comprehensive Viva-voce (virtual credit)	100	4	100	35	xx	xx

Total Credit Value: # 24 (20 + 4 virtual credits)

SEMESTER II

Code	Title of Course	Total Marks	Total Credits	End Sem. Exam Marks		Sessional Marks	
				Max	Min	Max	Min
ICA-201	Environmental and Pollution Control	100	3	60	21	40	14
ICA-202	Spectro-analytical Methods of Analysis– II	100	3	60	21	40	14
ICA-203	Modern Trends in Instrumentation	100	3	60	21	40	14
ICA-204	Fundamentals of Organic Reactions	100	3	60	21	40	14
ICA-205	Laboratory-I	100	3	60	21	40	14
ICA-206	Laboratory-II	100	3	60	21	40	14
ICA-207	Seminar	100	1	100	35	xx	xx
ICA-208	Assignment (Yoga, Physical Education /Language/Social Work/Environment))	100	1	100	35	xx	xx
ICA-209	Comprehensive Viva-voce (virtual credit)	100	4	100	35	xx	xx

Total Credit Value: # 24 (20 + 4 virtual credits)

SEMESTER III

Code	Title of Course	Total Marks	Total Credits	End Sem. Exam Marks		Sessional Marks	
				Max	Min	Max	Min
ICA-301	A) Industrial Analysis - I B) Medicinal Chemistry	100	3	60	21	40	14
ICA-302	Total Quality Management & ISO 9000	100	3	60	21	40	14
ICA-303	Industrial Analysis - II	100	3	60	21	40	14
ICA-304	Advanced Instrumental Methods of Chemical Analysis	100	3	60	21	40	14
ICA-305	Laboratory-I	100	3	60	21	40	14
ICA-306	Laboratory-II	100	3	60	21	40	14
ICA-307	Seminar	100	1	100	35	xx	xx
ICA-308	Assignment (Yoga, Physical Education /Language/Social Work/Environment))	100	1	100	35	xx	xx
ICA-309	Comprehensive Viva-voce (virtual credit)	100	4	100	35	xx	xx

Total Credit Value: # 24 (20 + 4 virtual credits)

SEMESTER IV

Code	Title of Course	Total Marks	Total Credits	End Sem. Exam Marks		Sessional Marks	
				Max	Min	Max	Min
ICA-401	Industrial Analysis – III	100	3	60	21	40	14
ICA-402	A) Concepts of Industrial Management and Intellectual Property Rights B) Introduction to nano science and nano technology	100	3	60	21	40	14
ICA - 403	Laboratory - I	100	3	60	21	40	14
ICA-404	Laboratory - II	100	3	60	21	40	14
ICA-405	project work/industrial training and project viva-voce	400	8	xx	xx	xx	xx
ICA-406	Comprehensive viva-voce (virtual credit)	100	4	100	35	xx	xx

Total Credit Value: # 24 (20 + 4 virtual credits)

SYLLABUS OF M.Sc. INSTRUMENTATION & COMMERCIAL METHODS OF INDUSTRIAL ANALYSIS (2020-2022)

First Semester **M.M.: 60**

ICA-101: Fundamentals of Quantitative Analysis and Separation Methods

Unit-I: Concepts involved in Analysis

Role of analytical chemistry, classification of analytical methods-classical and instrumental, types of instrumental analysis, selecting analysis method, neatness and cleanliness, laboratory operations and practices, good laboratory practices, techniques of weighing, errors, volumetric glassware-cleaning and calibration of glassware, sample preparation – dissolution and decompositions, selecting and handling reagents, Dissolution Testing, type, Aapplication. Laboratory notebooks, safety in the analytical laboratory, calibration and detection limits, proficiency testing.

Unit-II: Separation Techniques -I

(A) Solvent Extraction: Fundamental treatment, theoretical principle, classification, and factors favouring extraction, extraction equilibria, applications.

(B) Solid phase extraction and solid phase micro extraction, applications.

(C) Ion- Exchange: Theories, use of synthetic ion exchange in separation, chelating ion exchange resins, liquid ion exchangers, experimental technique.

Unit-III: Separation Techniques -II
An introduction to chromatographic methods, paper, thin layer and column chromatography, theory of chromatography, classification of chromatographic techniques, retention time, relationship between retention time and partition coefficient, the rate of solute migration, differential migration rates, band broadening & column efficiency, kinetic variables affecting band broadening, Electrophoresis and capillary electrophoresis,.

Unit-IV: Separation Techniques -III

GC, Principle of GC, plate theory for GC, instrumentation for GC, working of GC, Detectors used, applications, , HPLC, Principle of HPLC, Components of HPLC, Detectors used, instrumentation, applications in qualitative and quantitative analysis, comparison of GC and HPLC.

Unit-V: Separation Techniques -IV
Size exclusion chromatography, super critical fluid chromatography, affinity chromatography, HPTLC, Ion chromatography, pyrolytic gas chromatography.

Books Recommended

1. D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Methods, 5th ed.,,Thomson Asia Pvt. Ltd., Singapore (2003).
2. R.A. Day and A.L. Underwood, Quantitative Analysis, 6th ed., Prentice Hall of India Pvt. Ltd (1993).
3 G.D. Christian, Analytical Chemistry, 6th ed, John Wiley & Sons (2001).
4. S.M. Khopker, Environmental Pollution Analysis, 2nd ed., New Age International Pvt. Ltd.(2002).
5 A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Longman Singapore (1999)
6 G. W. Eving, Instrumental Methods of Chemical Analysis, 5th ed.,Mc-Graw Hill Book Company (1985)
7. Willard, Merritt, Dean, and Settle, Instrumental Methods of Analysis, 7th ed., C B S Publishers &Distributors (1986).

ICA-102: Stereochemistry and Thermo -analytical Methods **M.M.:60**

Unit-I: Stereochemistry

(a) Conformational analysis: Conformation of n-butane and cyclohexane, stability of conformers and energy profile diagram.

(b) Optical activity: Criteria for optical activity, stereoisomers, enantiomers and diastereomers, erythro and threo isomers, a general idea of symmetry elements.

(c) Racemic Modifications: Conglomerate, racemate and racemic solid solutions, a general idea of stereo selective synthesis.

(d) Resolution of Racemic modifications: by Chemical separation, chromatography, preferential crystallization and asymmetric transformation (a brief idea only).

Unit-II: Solution reactions: fundamental theory

The Law of Mass Action, Activity and Activity Coefficient, Factors affecting chemical reactions in solution, The ionic product of water, Electrolytic dissociation, Strengths of acids and bases, Solubility Product, Common ion effect, Effect of acid, temperature and solvent on the solubility of the precipitate, Complexation, stability of complexes, Complexones

Unit-III: Titrimetric and Gravimetric Methods of Analysis

General principles: Solvents in analytical chemistry, buffers, acid-base equilibria, concentration systems, stoichiometic calculation, acid-base titration, titration curves, acid base indicators, applications of acid-base titration, complexometric titration, metal-ion indicators, precipitation titration, Mohr's titration, Volhard's titration, adsorption indicators, Fajan's titration, titration curves in oxidation-reduction titration, redox indicators, applications of redox titrations and karl fischer Titration.

Unit-IV: Thermo-analytical Methods

Thermogravimetry, factors affecting thermogravimetric curves, derivative thermogravimetry (DTG), thermobalances, applications of thermogravimetry, differential thermal analysis, factors affecting DTA curve, instrumentation, applications of DTA.

Differential scanning calorimetry, theory, instrumentation, applications of DSC, thermometric titration, principle, classification, instrumentation and applications of thermometric titration.

Unit-V: Principles of Gravimetric Analysis

Stoichiometry of gravimetric reactions, formation and properties of precipitates, precipitation from homogeneous solution, nucleation, organic precipitations, applications of gravimetric analysis.

Books Recommended

1. D.A. Skoog, F.J. Holler and Nieman, Principles of Instrumental Methods, 5th ed., Thomson Asia Pvt. Ltd., Singapore (2003).
2. R.A. Day and A.L. Underwood, Quantitative Analysis, 6th ed., Prentice Hall of India Pvt. Ltd. (1993).
3. G.D. Christian., Analytical Chemistry, 6th ed, John Wiley & Sons (2000)
4. A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Longman, Singapore, pvt. Ltd. (1999)
5. G. W. Eving, Instrumental Methods of Chemical Analysis, 5th ed., Mc-Graw Hill Book Company (1985)
6. Ernest L. ELiel and Samuel H. Wilen,Stereochemistry of Organic Compounds , John Wiley & Sons (2003).

ICA-103: Spectro-analytical Methods of Analysis-I

M.M.:60

Unit-I: Colorimetry and Spectrophotometry

An introduction to spectrophotometric methods, a brief idea of wave properties of electromagnetic radiation, theory of spectrophotometry and colorimetry, ,conjugated dienes, woodward fieser rules for calculating absorption maxima in dienes,transition probability,types of absorption bands ,types of electronic transitions, chromophores, auxochromes, absorption and intensity shift limitations of Beer's Law, classification of methods of colour measurement, instrumentation single beam and double beam, photometric error, applications of spectrophotometry to inorganic and organic compounds (quantitative calculations), spectrophotometric titration.

Unit-II: Other Spectro-analytical techniques
(A) Introduction, general principle, instruments for nephelometry and tubidimetry, applications of nephelometry and turbidimetry to analytical chemistry.
(B) Dispersion Refrectometry and Flame photometry
(C) Polarometry, circular dichrosim (CD) and optical rotatory dispersion (ORD).

Unit-III: Emission Spectroscopy

Elementary idea of emission spectroscopy, introduction, elementary theory, instrumentation, types of flames, interferences, factors affecting flame photometry, applications to qualitative and quantitative analysis, limitations.

Unit-IV: Fluorescence and Phosphorescence Spectrophotometry

Theory of fluorescence and phosphorescence, quantum yield, factors affecting fluorescence and phosphorescence, relation between concentration and intensity, instrumentation, applications, an elementary idea of chemiluminiscence.

Unit-V: Kinetic of Slow and Fast reactions (An elementary study keeping in view its applications in analytical chemistry)

(A) Rates of chemical reaction, expression for reaction rate, rate constants, order of reaction, methods for determination of order of reaction, Arrhenius equation, Collision theory, failure of collision theory, Absolute reaction rate theory, unimolecular reactions, mathematical formulation of Lindemann's theory, catalysed reactions, Theory of homogenous catalysed reactions, kinetics of enzyme catalysed reactions, elementary idea of micellar catalysis.

(B) Study of fast reactions by stopped flow method, relaxation methods, flash photolysis method, photochemical reactions, kinetics of photochemical combination of hydrogen and chlorine, branched chain reactions, oscillatory reactions, applications of kinetic methods in finding out optimum conditions for different reactions

ICA-103: Spectro-analytical Methods of Analysis-I

M.M.:60

Unit-I: Colorimetry and Spectrophotometry

An introduction to spectrophotometric methods, a brief idea of wave properties of electromagnetic radiation, theory of spectrophotometry and colorimetry, ,conjugated dienes, woodward fieser rules for calculating absorption maxima in dienes,transition probability,types of absorption bands ,types of electronic transitions, chromophores, auxochromes, absorption and intensity shift limitations of Beer's Law, classification of methods of colour measurement, instrumentation single beam and double beam, photometric error, applications of spectrophotometry to inorganic and organic compounds (quantitative calculations), spectrophotometric titration.

Unit-II: Other Spectro-analytical techniques
(A) Introduction, general principle, instruments for nephelometry and tubidimetry, applications of nephelometry and turbidimetry to analytical chemistry.
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ICA-103: Spectro-analytical Methods of Analysis-I

M.M.:60

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Unit-II: Other Spectro-analytical techniques
(A) Introduction, general principle, instruments for nephelometry and tubidimetry, applications of nephelometry and turbidimetry to analytical chemistry.
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Unit-III: Emission Spectroscopy

Elementary idea of emission spectroscopy, introduction, elementary theory, instrumentation, types of flames, interferences, factors affecting flame photometry, applications to qualitative and quantitative analysis, limitations.

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(B) Study of fast reactions by stopped flow method, relaxation methods, flash photolysis method, photochemical reactions, kinetics of photochemical combination of hydrogen and chlorine, branched chain reactions, oscillatory reactions, applications of kinetic methods in finding out optimum conditions for different reactions

Books Recommended

1. John. R. Dyer, Applications of Absorption Spectroscopy of Organic compounds,9th ed.. Prentice Hall of India Pvt. Ltd. (1994).
2. Dudley H.Williams and Ian Fleming, Spectroscopic Methods in Organic Chemistry, 4th ed., Tata Mc-Graw Hill Book Company (1998).
3. R.M. Silverstein, G.Clayton Bassler and Terence C. Morrill, Spectroscopic Identification of Organic compounds, 6th ed, John Wiley & Sons (1998).
4. D.A. Skoog, F.J. Holler and Nieman, Principles of Instrumental Methods, 5th ed.,Thomson Asia Pvt. Ltd., Singapore (2003).
5. R.A. Day and A.L. Underwood, Quantitative Analysis, 6th ed., Prentice Hall of India Pvt. Ltd. (1993).
6. G.D. Christian., Analytical Chemistry, 6th ed, John Wiley & Sons (2000)
7. A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Longman Singapore (1999)

ICA-104: Electro-analytical Methods of Analysis

M.M.: 60

Unit-I: Fundamentals

Electrochemical cells, solution structure, potential in electroanalytical cells, Nernst equation, electrode potential the ideal polarized and non-polarized electrodes, faradiac reaction, variables in electrochemical cells, factors affecting electrode reaction rate and current, decomposition potential, back potential and over voltage.

Unit-II: Potentiometry

Introduction, reference electrodes, indicator electrodes, ion-selective electrodes and their applications in chemical analysis, instrumentation and measurement of cell unit, direct potentiometry, potentiometric titration, applications.

Unit-III: Polarography

Direct current polarography, basic principle, instrumentation, advantages and disadvantages of dropping mercury electrode, different kinds of limiting currents, components of poralographic waves, reversible and irreversible waves, pulse and A.C. polargraphy, applications of polarography to inorganic and organic compounds, elementary idea of stripping voltammetry, amperometric titrations.

Unit-IV: Conductometry and Coulometry

Conductometry as an analytical tool, applications of direct conductometric measurements, basis of conductometric titrations, applications of conductometry titration, constant current and controlled potential electro-gravimetry, separation of metals, coulometry at controlled potential, coulometry at constant current, applications.

Unit-V: Voltammetry

AC polarography, current sampled (TAST) polarography, normal pulse and differential pulse polarography, stripping voltammetry, linear sweep and cyclic voltammetry, chonopotentiometry, chronoamperometry.

Books Recommended

1. Allen J. Bard and Larry R. Faulkner, Electro-chemical Methods,2nd ed., John Wiley & Sons (2001).
2. G.D. Christian, Analytical Chemistry, 6th ed, John Wiley & Sons (2001).
3. A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Long man Singapore Ltd. (1999)
4. Galen W. Eving, Instrumental Methods of Chemical Analysis, 5th ed., Mc-Graw Hill Book company (1985).
5. Willard, Merritt, Dean, and Settle, Instrumental Methods of Analysis, 7th ed., C B S Publishers &Distributors (1986).

Second Semester

ICA -201: Environmental and Pollution Control M.M.: 60

Unit-I: Air Pollution

Atmospheric pollution, classification of air pollutants, sources of air pollutants and methods of control, sampling of aerosols, sampling of gaseous pollutants, analysis of SO_X, NO_X, CO-CO_2, hydrocarbons, effects of air pollutants, ozone layer, chlorofluorocarbons, acid rain, green house effect.

Unit-II: Water Pollution

Sampling and preservation of water, physical examination of water-colour, alkalinity, TDS, conductivity, temperature, odour, turbidity, hardness, chemical examination of water-determination of carbonates and bicarbonates, sulphate, chloride and flouride, nitrite and nitrate, iron, manganese, silica, cadmium, arsenic, chromium, lead, mercury, biological examination of water-dissolved oxygen, BOD, COD, MPN. Organic pollutant analysis-phenols and detergents.

Unit-III: Water treatment

Quality of water, standards of raw and treated water, objectives of waste water treatment, A brief idea of sedimentation, coagulation and flocculation, filtration, disinfection of water, activated sludge process, trickling filters, sludge treatment and disposal.

Unit-IV: Softening of water, corrosion and its control, removal of nitrogen and phosphorus. Removal of toxic compounds and refractory organics, removal of dissolved inorganic substances, Reverse osmosis.

Unit-V: (A) Soil Pollution

A brief idea of chemistry of soil. Macro and micro elements in soil and their functions, Pesticide,Soil profile and pollution, classification and degradation of pesticides, methods of pesticides analysis. Remediation of polluted soil.

(B) Noise Pollution

Sources, measurement, effects and control.

Books Recommended

1. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 3rd ed. Prentice Hall of India Pvt. Ltd.(1998)

1. C.S.Rao, Environmental Pollution Control Engineering, 3rd ed., Wiley Eastern Ltd.New Age International Pvt.Ltd. (1995).

2. Metcalf & Eddy, Waste Water Engineering, Tata McGraw Hill, New Delhi (2003).

3. C.Harold Wright, A Hand book of Soil Analysis, 4th ed., Logas press New Delhi –

4. Thomous S. Spiro and William M. Stiglicini, Chemistry of the Environment, Prentice Hall of India Pvt. Ltd. (2002).

5. Nicholas P. Cherimisinoff, Biotechnology for Waste and wastewater treatment, Prentice Hall of India Pvt. Ltd. (2001).

7. Jarry A. Nathanson, Basic Environmental Technology, 4th ed., Prentice Hall of India Pvt. Ltd. (2003). 8. Raymond W. Miller and Roy L. Donalvee, Soil in Our Environment, 7th ed, Prentice Hall of India Pvt. Ltd. (1997).

9. Nylie C. Brady, The Nature and Properties of Soil, 10th ed., Prentice Hall of India Pvt. Ltd. (1996).

ICA-202: Spectroanalytical Methods of Analysis- II

M.M.: 60

Unit-I: Atomic Absorption and Emission Spectroscopy.

Theory of atomic spectroscopy, the origin of spectral transition, the populations of energy levels, the factors influencing spectral width, atomic absorption spectroscopy (AAS), instrumentation, interferences, applications, various non-flame emission sources, applications of atomic emission spectroscopy, comparison of atomic emission and atomic absorption methods, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), instrumentation of ICP-AES, applications of ICP-AES, Comparison of ICP-AES with AAS.

Unit-II: Infrared Spectroscopy

Theory of Infrared absorption, vibrational modes, vibrational coupling, Near IR Spectroscopy ,instrumentation, dispersive and non-dispersive instrument, FTIR, sampling techniques qualitative applications and interpretation of spectra, quantitative applications. A brief idea of Raman spectroscopy.

Unit-III: Nuclear Magnetic Resonance Spectroscopy

Theory of NMR, chemical shift and spin-spin splitting, relaxation process of saturation, environmental effects on NMR spectra, instrumentation, CW or FT NMR instrument, Rules governing the interpretation of first order spectra, applications to quantitative analysis.

Unit-IV: Carbon-13 NMR

Historical development, proton decoupling-broad band, Off-resonance and pulsed or gated decoupling, nuclear overhauser enhancement, polarization transfer experiments-DEPT and INEPT chemical shifts, spin-spin coupling impacts, application of ^{13}C NMR to structure determination, two-dimensional NMR spectroscopy, principle, the COSY experiment, the COSY experiment with double quantum filter (COSY-DQF), the NOESY experiment, three-dimensional NMR experiment, APT and INADEQUATE techniques.

Unit-V: Mass Spectrometry

Theory of mass spectrometry, practical considerations, ion production, depletion of ions, ion detector, calibration, other ionization techniques: chemical ionization, fast atom bombardment (FAB), and electrospray, interpretation of the mass spectrum of the compound, , Mc Lafferty rearrangement ,Mass analyzers, determination of molecular formula, nitrogen rule, general fragmentation modes, applications of mass spectrometry.

Books Recommended

1. John. R. Dyer, Applications of Absorption Spectroscopy of Organic compounds, 9th ed.,Prantice Hall of India Pvt. Ltd. (1994).
2. Dudley H.Williams and Ian Fleming, Spectroscopic Methods in Organic chemistry, 4th ed., Tata Mc-Graw Hill Book company (1998).
3. R.M.Silverstein, G.Clayton Bassler, and Terence C. Morrill, Spectroscopic Identification of Organic Compounds, 6th ed., John Wiley & Sons (1998).
4. C.N. Ban well, Fundamentals of Molecular Spectroscopy, Tata Mc-Graw Hill Book company (1998).
5. Manas Chanda, Atomic Structure and Chemical Bond, Tata Mc-Graw Hill Book company (1998).
6. S.M.Khopkar, Basic concepts of Analytical Chemistry, 3rd ed., New Age International Ltd., (2008).

203: New trends in Instrumentation **M.M.:60**

Unit-I: Statistical Treatment of Data-I

Types of errors, accuracy and precision, rounding off, significant figures, normal distribution of errors, statistical treatment of finite samples (mean, median, range & average deviation), t-test, confidence interval of the mean, standard error of a mean, test of significance, comparison of two means, F-test, rejection of data, Q-test, bivariate data, Quality control charts, relationship between variables, correlation & regression, principle of least squares.

Unit-II: Statistical Treatment of Data-II

Overview of quantitative analysis of drugs, validation of analytical procedure in pharmaceutical formulation (LOD, LOQ, Robustness, Specificity, Accuracy, Precision, Selectivity, Linearity, Ruggedness, Reproducibility, Repeatability), Recovery analysis, Error bars, Study design.

Unit-III: Statistical Treatment of Data-III

Chi square, ANOVA-1 way classification, ANOVA-2 way classification, Lotka-Voltra Model and Lesle's matrix model, Box model and Gaussian Plume Model, normal distribution, skewness.

Unit-IV: Spectro-analytical methods of analysis

Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM) and its applications, Microwave Spectroscopy, Comparison of Electron Microscopy with electron spectroscopy.

Unit-V: Photoelectron Spectroscopy

Ultraviolet (U.V.) and X-ray Photoelectron Spectroscopy, basic concepts and applications. Concept of AUGER Photoelectron Spectroscopy and applications. Determination of kinetic energy of an electron by using different methods, Difference between AUGER and Fluorescence phenomenon.

Books Recommended

1. John. R. Dyer, Applications of Absorption Spectroscopy of Organic compounds, 9th ed.. Prentice Hall of India Pvt. Ltd. (1994).
2. Dudley H.Williams and Ian Fleming, Spectroscopic Methods in Organic Chemistry, 4th ed., Tata Mc-Graw Hill Book Company (1998).
3. R.M. Silverstein, G.Clayton Bassler and Terence C. Morrill, Spectroscopic Identification of Organic compounds, 6th ed, John Wiley & Sons (1998).
4. D.A. Skoog, F.J. Holler and Nieman, Principles of Instrumental Methods, 5th ed.,Thomson Asia Pvt. Ltd., Singapore (2003).
5. R.A. Day and A.L. Underwood, Quantitative Analysis, 6th ed., Prentice Hall of India Pvt. Ltd. (1993).
6. G.D. Christian., Analytical Chemistry, 6th ed, John Wiley & Sons (2000)
7. A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Longman Singapore (1999)
8. Jagmohan, Organic Spectroscopy-Principles and applications, 2nd ed, Narosa Publishing House, New Delhi
9. C.S. Rao, Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Age International Ltd., (1995)

ICA -204: Fundamental of Organic Reactions

M.M.:60

Unit-I: Nucleophilic substitution

Mechanism of SN^1 and SN^2 reactions, SN^i and SET mechanism, The neighboring group mechanism, Effects of substrate structure, Attacking nucleophile, Leaving group and reaction medium on SN^1 and SN^2 reactions, Benzyne reaction, Evidences in favour of benzyne reaction.

Unit-II: Electrophilic substitution

Electrophilic substitution reaction of benzyne, Nitration halogenations, Sulphonation , Friedel craft reaction, Energy profile diagram, The ortho/ para ratio, IPSO attack, Diazonium coupling reaction, Gattermann-koch reaction, Vilsmeir reaction.

Unit-III: Elimination reaction

Mechanism of E-1, E-2 and E1CB reactions, Difference between substitution and elimination reactions, Saytzeff rule, The Hoffmann rule, Effects of substrate structure, Nature of base, Nature of solvents and temperature on elimination reactions.

Unit-IV: Addition reaction

Electrophilic additions, Markovnikov's rule, Peroxide effect, Hydroboration, sharpless asymmetric epoxidation, Regio and chemoselectivity, Diel's – Alder reaction, ozonolysis, Hydrogenation of alkene and alkynes, Mechanism of Aldol, Claisen, Perkin and Benzoin condensations.

Unit-V: Free radicals

Stability of free radicals, Polymerization, halogenations of alkanes via chain reaction, Bromination by N- bromo succinimide (NBS), Addition of halogens and halogen acids, Autooxidation, Sandmeyer reaction, Hansdiecker reaction, Free radical rearrangement reaction.

Books Recommended

1. Advanced organic chemistry- reactions, mechanism and structure, Jery March, John Wiley.
2. Organic chemistry, R.T Morrism and R.N. Boyel, Prentice Hall.
3. Reaction mechanism in organic chemistry, S.M. Mukherji and S.P. Singh. Trinity Publisher, New Delhi.
4.Advanced organic chemistry, Jagdamba singh & L.D.S. Yadav. Pragati Prakashan, Meerut.
5. Advanced general organic chemistry, S.K. Ghosh. New central Book Agency(p) ltd. Kolkata

Third semester

ICA-301: Industrial Analysis-I (Major Elective) M.M.: 60

Unit –I : Pharmaceutical division - quality assurance, R&D, drug formulations, drug assay ,drug dissolution, bioanalytical development,Profile of a quality control laboratory for chemical division in Pharmaceutical unit, structure activity relationship, process development in Pharmaceutical industries, API , physiochemical properties of drug.

Unit – II: Toxicokinetic
Toxicology acute and chronic toxicity, LD_{50} and $ED_{50,}$ routes of drug administration, adverse drug reaction, adverse drug effect, therapeutic index, therapeutic drug monitoring, dose response relationship.

Unit -III: General Chemistry, mode of action and method of analysis of drugs belonging to following classes :

(a)***Antipyretics & analgesics***: Paracetamol, Aspirin and Ibuprofen

(b)***Antibiotics***: Ampicillin, Amoxicillin and Cloxacillin

(c)***Antifungal agents***: Clotrimazole and miconazole

Unit – IV: (a) ***Sulpha drugs***: Sulphanilamide, Sulphaguanidine and Sulphadiazine

(b) ***Antitubercular drugs***: Isoniazide and Rifampicin

(c) ***Expectorants***: Codeine phosphate and Papaverine hydrochloride

(d) ***Bronchodilators***: Ephedrine, Salbutamol and Theophylline

(e)***Hypnotics and Sedative***: Phenobarbitone

(f) ***General Anesthetic***: Benzocaine

Unit – V: A brief chemistry and mode of action of following drugs **(method of analysis excluded)**

(a) ***Cardiac glycosides***: Digoxin and Digitoxin

(b) ***Antihypertensive***: Clonidine and Methyldopa

(c) ***Antileprotic drugs***: Dapsone and Clofaximine

(d) ***Anticancer agents***: Alkylating agents only

Books Recommended

1. Foye's principles of medicinal chemistry. David A. Williams, Thomas L. Lemke, Fifth Edition. Lippincott Williams & Wilkins.
2. Essentials of medicinal Pharmacology, K.D.Tripathi, 4th Edition . Jaypee Brothers Medical Publishers Ltd.
3. Medicinal chemistry Vol. I & II. A. Burger, Willey interscience, 1970
4. Pharmacology & Pharmacotherapeutics, Vol. I & II. R.S. Satoskar & S.C. Bhandarkar, Popular Prakashan 1978.
5. A Textbook of medicinal chemistry. P. Parimoo.

Third Semester

ICA-301: Medicinal Chemistry(Major Elective) M.M.: 60

Unit –I: General Pharmacological Principles
Physiochemical properties of drug, Pharmacokinetics: Membrane Transport, Absorption and Distribution of Drugs, Pharmacodynamics and Kinetics of Elimination, Structure activity relationship, Acute and Chronic toxicity, microsomal enzyme induction and its consequences.

Unit – II: Clinical Chemistry
Composition of blood, collection and preservation of sampler, clinical analysis: Serum electrolyte, blood urea nitrogen, uric acid albumin, globulin acid and alkaline phosphate, Immunoassay, principle of radio immunoassay and application.

Unit -III: General description of following drugs:

a) Antibiotics: Penicillin, Tetracyclines and Chloramphenicol
b) Antiviral drugs and its classification
c) Antifungal agents: Clotrimazole, miconazole and Terbinafine
d) Sulpha drugs: Sulphanilamide, Sulphaguanidine and Sulphadiazine
e) Immunosuppressant Drugs
f) Antiseptics, Disinfectants and Ectoparasiticides

Unit – IV: A brief Introduction of following drugs:

Antipyretics & analgesics, Sedative & hypnotics, cardiovascular drugs, antihistamine, Non Steroidal anti inflammatory drugs (NSAIDs) , Expectorants & bronchodilators , Antimalarial , General and local anaesthetics, Central Nervous System Stimulants.

Unit – V: An elementary idea of the following:

a) Antimycobacterial drugs
b) Drugs to combat AIDS
c) Therapeutic radioisotopes and imaging radioisotopes
d) Anticancer drugs
e) Anthelmintic Drugs

Books Recommended

1. Foye's principles of medicinal chemistry. David A. Williams, Thomas L. Lemke, Fifth Edition. Lippincott Williams & Wilkins.
2. Essentials of medicinal Pharmacology, K.D.Tripathi, 4th Edition . Jaypee Brothers Medical Publishers Ltd.
3. Medicinal chemistry Vol. I & II. A. Burger, Willey interscience, 1970
4. Pharmacology & Pharmacotherapeutics, Vol. I & II. R.S. Satoskar & S.C. Bhandarkar, Popular Prakashan 1978.
5. A Textbook of medicinal chemistry. P. Parimoo.

ICA - 302: Total Quality Management and 1S0 - 9000

M.M.:60

Unit - I

Management of quality systems, ISO-9000-An overview, clauses/ requirement of ISO-9000, significance and scope. Steps for ISO- 9000 implementation, series of ISO, case studies of ISO.

Unit - II

Elements of TOM, total employee involvement (TEI), total waste elimination (TWE), total productive maintenance (TPM), total quality control (TQL), cost of quality, cutting the cost of quality, Quality manual.

Unit –III

(A) Kaizen: Concept and implementation, Types of Kaizen vs. Innovation

(B) Quality Circle: Concept, 4-M and 5-S concept, problem solving tools and implementation, case studies.

Unit - IV

Implementation of TOM, management of change (MOC), faces of resistance, approach to TOM, case study of total quality management (changing the company culture), control charts.

Unit – V

Quality assurance and TQM for analytical laboratories, accreditation or certification for laboratories, motivation of the analytical laboratory for TQM, quality in analytical laboratory, method validation: an essential tool in TQM, implementation of quality programmes in multifunctional laboratories, reference materials.

Books Recommended

1. G.Gardon,F.James and I .Mcmanus, Total Quality Management for Software, 1st ed. Comdex Computer Publishing (1998).
2. Dr. Sunil Sharma, TQM in Indian Engineering Industries, 1st ed., Business Publication (1997).
3. Ron Collard, Total Quality Success Through People, 2nd ed., Jaico Publishing House (2002).
4. A.K. Sinha and Pankaj Srivastava, Earth Resources and Environmental Issues.
5. David Hoyle, ISO9000, 1st ed., Butter Wolter (1996).
6. Gary E. Maclean, Documenting Quality for ISO 9000 and Other Industry Standerds, Tata Mc Graw Hill (1996).
7. J.M. Juran, Quality Planning & Analysis, 3rd ed., Tata Mc Graw Hill (1996).
8. N.Logothetis, Managing for the Total Quality, Prentice Hall of India (P) Ltd. (1997).
9. M. Parkany, Quality Assurance and TQM for Analytical Labs, 1st ed., Royal Chemical Society (1995)
10. B.W. Wendawiar

ICA - 303: Industrial Analysis - II

M.M.: 60

Unit - I: Analysis of Ores and Alloys

Principle of ore dressing, analysis of the following:

(i) Bauxite, Haematite (ii) Steel, Brass

(iii) Coal, Portland cement (iv) Lubricants and Oils

Unit – II: Analysis of Polymers and Cosmetics

(i) Polymers: General idea of polymers, analysis of plastics, fibers and rubbers with reference to Nylon 6, polyethylene phthalate (PET), polyester resin, phenol-formaldehyde resin, epoxy resin, polyethylene, natural rubber, styrene-butadiene rubber, analysis by IR, pyrolytic gas chromatography.

(ii) Cosmetics. General introduction, analysis of shampoo, hair spary, deodrants, sunscreen, creams and lotions.

Unit – III: Analysis of Soaps and Detergents

General idea of soaps and detergents, sampling, separation and identification of surfactants in detergent bases, determination of surfactants: anionic e.g. alkyl aryl sulphonates, cationic, non-ionic, determination of abrasives, ammonia, carbonates, carboxymethyl cellulose, ethanol and isopropyl alcohol, glycerine, silicates, sulphates, phosphates, moisture, saponification value, iodine value, acid value.

Unit –IV: Analysis of Paints, Varnish and Lacquer

General introduction, tests on the total coating; non-volatile and volatile contents, water content of paint and paint products, flash point, isolation and determination of pigment, isolation of vehicle, isolation of thinner, isolation and determination of the binder content, identification of polymers, resins and oils, identification of plasticizer, analysis of the vehicle, analysis of drying oils, epoxide analysis.

Unit – V: Analysis of Glass

General introduction, constitution of glasses, methods of analysis: sampling and sample preparation, composition, analysis, chemical analysis of silicon, barium, arsenic, antimony, total (Fe_2O_3, Al_2O_3, TiO_2, MnO), calcium, magnesium, total alkalies ($Na_2O + K_2O$), boron, analysis of colouring additives [Cr, Co, Cu, Fe, Mn, Ni, Ti, (Pb & Ba)]. Application of flame and emission spectroscopy to glass analysis. A brief idea of microscopy. Blisters in glasses.

Books Recommended

1. A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Long man Singapore Ltd. (1999)
2. P.C. Dele, Soaps and Detergents, 2nd ed., CBS Publication (1996).

ICA 304: Advanced Instrumental Methods of Chemical Analysis

M.M.: 60

Unit - I – Diffraction Techniques

General theory and instrumentation of neutron diffraction and X-rays diffraction. Application of X-rays diffraction for polymer characterization and structure of complexes. Applications of neutron diffraction to structure of magnetic materials.

Unit - II – X-ray spectroscopy and Photoacoustic Spectroscopy

X-ray absorption, instrumentation, X-ray absorption in chemical analysis, X-ray emissions, X-ray fluorescence methods, fluorescence instruments, X-ray fluorescence in analysis, particle induced X-ray emission (PIXE), Photoacoustic spectroscopy, principle, instrumentation, applications.

Unit - III: ESR Spectroscopy

General theory, instrumentation and important applications of ESR spectroscopy,spin labelling ESR Spectroscopy, Multiple Resonance ENDOR and ELDOR Effect, characterization of metal complexes by ESR.

Unit – IV: Mossbauer Spectroscopy

General theory, instrumentation and important applications of Mossbauer spectroscopy

Unit - V - Industrial Process Instruments and Automatic Analysis

Overall analytical procedures for analysis of an organic and inorganic material, industrial process analyzer, infrared process analyzer. On-line potentiometric analyzer, process gas chromatography, on-line GC/Mass and GC/IR, continuous on-line process control, automatic chemical analysis, automatic elemental analyzer.

Books Recommended

1. D.A. Skoog, F.J. Holler and Nieman, Principles of Instrumental Methods, 5th ed., Thomson Asia Pvt. Ltd., Singapore (2003).
2. R.A. Day and A.L. Underwood, Quantitative Analysis, 6th ed., Prentice Hall of India Pvt. Ltd. (1993).
3. G.D. Christian., Analytical Chemistry, 6th ed, John Wiley & Sons (2001).
4. Willard, Merritt, Dean, and Settle, Instrumental Methods of Analysis, 7th ed., C B S Publishers &Distributors (1986).

Fourth Semester

ICA-401: Industrial Analysis – III

M.M.:60

Unit - I - Analysis of Dyes

Introduction to dyes, classification and relation between colour and chemical constitution.

(i) General methods for analysis of colours used in foods, drugs and cosmetics.

(ii) Brief idea about synthesis and analysis of following classes of dyes: azo dyes: indigoid dyes, triphenyl methane dyes.

Unit - II: Analysis of Food and Food products

The chemical and nutritional composition of foods. Analysis of trace elements such as As, Cd, Pb in food. Analysis of tea, wines, milk, butter, cheese. Approximate analysis of honey. A general idea about preservatives.

Unit - III - Analysis of Pesticides and Fertilizers

(a) Pesticides: General introduction, brief classification and mode of action of pesticides. Analysis of pesticides in general with reference to DDT, dieldrin, diphacinone, heptachlor, malathion, parathion, sevin.
(b) Fertilizers: Sampling and sample preparation, determination of water, total phosphorus, potassium, total nitrogen, urea.

Unit - IV: Analysis of Petroleum and Petroleum Products

(i) Introduction, determination of flash and fire point, API Gravity, distillation of petroleum products, specific gravity of petroleum, cloud and pour points, water in petroleum products. Aniline point, neutralization value of petroleum products, lead anti-knock compounds in gasoline, sulphur in petroleum products.

(ii) A General idea of (a) Embalming chemicals (b) Dry cleaning agents and (c) Materials used in match composition.

Unit – V: Analysis of Wood and Pulp

(i)Analysis of Wood: Sampling, determination of methoxyl group in wood. A brief idea of analysis of moisture in wood chips and saw dust by toulene methods, cellulose in wood.

(ii)Analysis of Pulp: General introduction, sampling, determination of cellulose in pulp, permanganate number of pulp, copper number of pulp.

(iii)Analysis of Paper: General introduction, sampling of paper, determination of reducible sulphur in paper and paper boards, moisture in paper, ash in paper, starch in paper, cellulose in paper, copper number of paper, acid-soluble iron in paper.

Books Recommended

1. A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Long man Singapore Ltd. (1999)
2. P.D. Sethi, Quantitative Analysis of Drugs, 2nd ed. CBS Publications, New Delhi (1993).

ICA-402: Concepts of Industrial Management and Intellectual Property Rights(Major Elective) **M.M.: 60**

UNIT – I: Concepts of Industrial Management

Nature and significance of management, functions of management, social responsibilities of management. New industrial policy. Multinationals. Nature, scope and significance of personnel functions in modern organizations. Human resource planning, recruitment and selection process, employees training.

UNIT – II: Intellectual Property Rights

TRIPs – Its scope and options, the changing R & D processes and IPR, The IPR tool kit, patents, the patenting process, patent cooperation treaty.

UNIT – III: Intellectual Property Protections of Living Species

Compatibility between conventions, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, some case studies: The basmati rice issue, revocations of turmeric patent, revocation of neem patent.

UNIT – IV: Exercising and Enforcing of Intellectual Property Rights

Rights of an IPR owner, licensing agreements, criteria for patent infringement, case studies of patent infringement, IPR – a contract, unfair competitions and control, provisions in TRIPs, some case studies.

UNIT- V: Role of Patents in the Pharmaceutical Industry

Recent changes in IPR laws impacting pharmaceutical industry, intellectual cooperation in the pharmaceutical industry, some case studies

Books Recommended

1. Fisher, Schoenfeldt, and Shaw, Human Resources Management, 3rd ed. , All India Publishers and Distributors, Channai (1997).
2. P.B. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata Mc Graw Hill (2001)
3. Steve Smith, The Quality Revolution, 1st ed., Jaico Publishing House (2002).
4. T.R. Bhanga and N.K. Agrawal, Industrial Engineering and Management Science, 10th ed.,Romesh Chandra Khanna ,Khanna Publishers (2002).
5. Harold Koontz and Heinz Weihrich, Essential of Management, 5th ed., Tata Mc graw Hill Publishers 6. P.C. Tripathi and Reddy, Principle of Management 2nd ed., Tata Ltd. Company, New Delhi (1996).
7. M..Adhikary,Economic Environment of Business,6th ed., Educational Publishers, New Delhi (1996).
8. Derek Biddle and Robin, Human Aspects of Management, 2nd ed., Delhi (1997).
9. Jean F. Hartley and Geoffrey, Employee Relations, 1st ed., Efficient Offset Delhi (1998).
10.C.B. Mamoria, Personal Management, 12th ed., Himalaya Publishing Mumbai (1994)

ICA-402: Introduction to Nano Science and Nano Technology(Major Elective) **M.M.: 60**

UNIT-I : Essentials of Quantum Mechanics & Thermodynamics for Nanotechnology:
Introduction to Quantum Mechanics; Schrodinger equation and expectation values, Solutions of the Schrodinger equation for free particle & particle in a box, thermodynamic laws, heat capacity and relationship between Cp and Cv, enthalpy, entropy, Basic Magnetic Phenomena: Diamagnetism, Paramagnetism, Ferromagnetism, Ferrimagnetism, Anti-ferromagnetism

UNIT-II: Introduction to Nanomaterials and its types, nanoparticles, historical background, properties of nanomaterials, role of size in nanomaterials, Zero-, One-, Two- and Three- dimensional nanostructure, Surface Plasmon Resonance

UNIT-III: Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation, Metal nanocrystals by reduction, Sol-gel synthesis, Microemulsions, Solvothermal synthesis, Thermolysis routes, Microwave heating synthesis, Electrochemical synthesis, Photochemical synthesis, Synthesis in supercritical fluids

UNIT-IV: Fabrication of Nanomaterials by Physical Methods: Inert gas condensation, Arc discharge, Plasma arc technique, RF plasma, MW plasma, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and Electro deposition.

UNIT-V: Nanocomposites: An Introduction, Types of Nanocomposite (i.e. metal oxide, ceramic, and polymer based), Semiconductor nanoparticles and its application, an elementary idea of nanolithography.

Books Recommended

1. Nanochemistry: A chemical approach to nanomaterials by G. A. Ozin, A. C. Aresnault, L. Cadematriri.
2. Handbook of Semiconductor Nanostructures and Nanodevices Vol 1-5- A. A. Balandin, K. L. Wang.
3. Chemistry of Nanomaterials : Synthesis, properties and applications by CNR Rao.
4. Nanocomposite science and technology – P.M. Ajayan, L.S. Schadler, P.V. Braun, Wiley, New York.

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ICA – 105 and 106
I- Semester
Practical Examinations

M.M.: 100

One day 6-8 hrs. (Each course)
Two exercises to be given in each examination

CLASSICAL

1. Neutralization titration
   (a) Determination of Acidity.
   (b) Determination of free carbon dioxide.
   (c) Determination of alkalinity.

2. Complexometric titration
   (a) Determination of temporary and permanent hardness.
   (b) Determination of total, calcium and magnesium hardness.

3. Precipitation titration
   (a) Determination of chloride.

4. Redox titration
   (a) Determination of ferrous iron.
   (b) Determination of copper.

INSTRUMENTAL

1. Spectrophotometric/ Colorimetric determination
   (a) Determination of nickel.
   (b) Determination of hexavalent chromium.

2. Conductometric determination
   (a) Determination of strength of acid against standard alkali.
   (b) Find out the strength of mixture of acids in an unknown mixture.

3. pH metric determination
   (a) Determination of strength of acid against standard alkali.
   (b) Find out the strength of mixture of acids in an unknown mixture.

4.Chromatographic determination
   a) Identification of a sample compound and its separation from a binary mixture by (i) Paper chromatography (ii) Thin layer chromatography and(iii)Electrophoresis.

SEPARATION TECHNIQUES

1. Determination of the distribution coefficient of iodine between CCL_4 and water.

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ICA – 205 and 206
II- Semester
Practical Examinations

One day 6-8 hrs. (Each course) **M.M.: 100**
Two exercises to be given in examination

CLASSICAL

1. Physio-chemical analysis of water
   (a) Determination of total dissolved and suspended solids.
   (b) Determination of residual chlorine.
   (c) Determination of chlorine demand.
   (d) Determination of bicarbonate and carbonate alkalinity.
   (e) Find out the concentration of sulphite.

2. Measurement of organic pollutant in the water
   (a) Determination of Dissolved Oxygen (DO).
   (b) Determination of Biological Oxygen Demand (BOD).
   (c) Determination of Chemical Oxygen Demand (COD).

INSTRUMENTAL

1. Spectrophotometric/ Colorimetric determination
   (a) Determination of nitrite.
   (b) Determination of phosphate.
   (c) Determination of sulphide.

2. Conductometric determination
   (a) Determination of strength of alkali against standard acid.
   (b) Find out the strength of mixture of acids in an unknown mixture against N/10 NaOH.

3. pH metric determination
   (a) Determination of strength of alkali against standard acid.
   (b) Find out the strength of mixture of acids in an unknown mixture against N/10 NaOH.

4. Determination of oil and grease in water sample by gravimetric method.

ICA – 305 and 306
III- Semester
Practical Examinations

M.M.: 100

One day 6-8 hrs. (Each course)
Two exercises to be given in examination

CLASSICAL

1. Determination of Organic Nitrogen.
2. Determine the saponification value of given oil sample.
3. Determination of Iodine Value in given oil sample.

INSTRUMENTAL

1.Spectrophotometric/ Colorimetric determination

b) Find out the composition of binary mixture calorimetrically.
c) Determination of nitrate.
d) Determination of sulphide.
e) Determination of copper.
f) Determination of iron.
g) Determination of Ammonnia Nitrogen.

2.Measurement of different parameters in food and medicines

a)Determination of Ash.
b)Determination of moisture.
c)Determination of Loss on Drying (LOD)
d)Determination of Residue on Ignition

3.Determination of sulphate by Turbidometric method.

4.Determination of adsorption isotherm of acetic acid from aqueous solution by using activated charcoal.

ICA – 403 and 404
IV- Semester
Practical Examinations

M.M.: 100

One day 6-8 hrs. (Each course)
Two exercises to be given in examination

CLASSICAL

1. Determination of aspirin by Volumetric Assay.
2. Isolation of Starch from Potato.
3. Estimation of Lactose in milk.
4. Isolation of Casein from milk.
5. determination of Caffeine

INSTRUMENTAL

1. Spectrophotometric/ Colorimetric determination
   a. Find out the composition of binary mixture calorimetrically.
   b. Determination of Salicylic acid by Spectrophotometer.
   c. Determination of Ascorbic acid by Spectrophotometer.
   d. Determination of Paracetamol in given tablet by Spectrophotometer.

2. Measurement of different parameters in medicines

   a) Volumetric Estimation of ibuprofen
   b) Determination aspirin by Volumetric Method.
   c) Volumetric assay of ascorbic acid by iodometric titration
   d) Volumetric assay of ampicillin

3. To Separate the Paracetamol and ibuprofen by TLC method.