V- SEMESTER

Course Code 12 A: ANALYTICAL METHODS IN CHEMISTRY-

QUANTITATIVE ANALYSIS

Credits: 03

ANALYTICAL METHODS IN CHEMISTRY- QUANTITATIVE ANALYSIS

SKILL ENHANCEMENT COURSE (ELECTIVE)

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1) Identify the importance of solvent extraction and ion exchange method.
2) Acquire knowledge on the basic principles of volumetric analysis and gravimetric analysis.
3) Demonstrate the usage of common laboratory apparatus used in quantitative analysis.
4) Understand the theories of different types of titrations.
5) Gain knowledge on different types of errors and the minimization methods.

II. Syllabus:

Unit-1: Quantitative analysis-1 (9 hours)

A brief introduction to analytical methods in chemistry. Principles of volumetric analysis, concentration terms- Molarity, Molality, Normality,v/v, w/v, ppm and ppb, preparing solutions- Standard solution, primary standards and secondary standards.. Description and use of common laboratory apparatus- volumetric flask, burette, pipette, beakers, measuring cylinders.

Unit-2: Quantitative analysis-2 (9 hours)

Principles of volumetric analysis: Theories of acid-base (including study of acid-base titration curves), redox, complex metric, iodometric and precipitation titrations-choice of indicators for the saturations. Principles of gravimetric analysis: precipitation, coagulation, peptization, coprecipitation, post precipitation, digestion, filtration, and washing of precipitate, drying and ignition.

Unit-3: Treatment of analytical data (9 hours)

Types of errors- Relative and absolute, significant figures and its importance, accuracy - methods of expressing accuracy, errors- Determinate and indeterminate and minimization of errors, precision-methods of expressing precision, standard deviation and confidence interval.

Unit-4: Separation techniques (9hours)

Solvent Extraction: Introduction, principle, techniques, factors affecting solvent extraction, Batch extraction, Continuous extraction and counter current extraction. Synergism.

Application-Determination of Iron(III). Ion Exchange method: Introduction, action of ion exchange resins, applications.

UNIT-5: Analysis of water (9 hours)

Determination of dissolved solids, total hardness of water, turbidity, alkalinity, Dissolved oxygen, COD, determination of chloride using Mohr's method.

III. Suggested Co-Curricular Activities:

1) Training of students by related industrial experts.
2) Assignments, Seminars and Quiz(on related topics).
3) Visits to laboratories, firms, research organizations etc.
4) Invited lectures and presentations on related topics by field/industrial experts.

IV. List of Reference Books:

1) Fundamentals of Analytical Chemistry by F.James Holler, Stanley R Crouch, DonaldM.West and Douglas A. Skoog, Ninth edition, Cengage.
2) Analytical Chemistry by Gary D.Christian, Purnendu K.Dasgupta and KevinA. Schug, Seventh edition, Wiley.
3) Quantitative analysis by R.A.DayJr.and A.L.Underwood, Sixth edition, Pearson.
4) Text book of Vogel's Quantitative Chemical Analysis,Sixth edition, Pearson.
5) Text book of Environmental Chemistry and Pollution Control by S.S.Dara and D.D.Mishra, Revised edition, S Chand & Co Ltd.

V- SEMESTER

Course Code 12 A: Analytical Methods in Chemistry – Quantitative analysis:

Credits: 01

Analytical Methods in Chemistry – Quantitative analysis:

V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1) Estimate Iron(II)using standard Potassium dichromate solution
2) Learn the procedure for the estimation of total hardness of water
3) Demonstrate the determination of chloride using Mohr's method
4) Acquire skills in the operation and calibration of pH meter
5) Perform the strong acid vs strong base titration using pH meter

VI. Laboratory course Syllabus:

1) Estimation of Iron(II)using standard Potassium dichromate solution (using DPA indicator)
2) Estimation of total hardness of water using EDTA
3) Determination of chloride ion by Mohr's method
4) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
5) Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid, (ii) Ammonium chloride-ammonium hydroxide.
6) pH metric titration of (i) strong acid vs strong base,(ii)weak acid vs. Strong base.
7) Determination of dissociation constant of a weak acid.

VII. Co-Curricular Activities:

Mandatory:*(Lab /field training of students by teacher:(lab:10+field:05):*

1) **For Teacher**: Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques / skills of calibration of pH meter, Strong acid vs strong base titration using pH meter, determination of chloride ion, estimation of water quality parameters and estimation of Iron(II).

2) **For Student**: Student shall visit a related industry / chemistry laboratory in universities / research organizations/private sector facility and observe various methods used for the analysis of water. Write their observations and submit a hand written fieldwork /project work report not exceeding10pages in the given format to the teacher.

3) Max marks for Field work / projectwork Report:05.

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5) Unit tests (IE).

VIII. List of Reference books:

Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

V- **SEMESTER**

Course 12 B : Environmental Chemistry

Credits: 03

Learning Outcomes:

Students after successful completion of the course will be able to:

1) Understand the environment functions and how it is affected by human activities.
2) Acquire chemical knowledge to ensure sustainable use of the world's resources and
3) ecosystems services.
4) Engage in simple and advanced analytical tools used to measure the different types of pollution.
5) Explain the energy crisis and different aspects of sustainability.
6) Analyze key ethical challenges concerning biodiversity and understand the moral principles, goals
7) and virtues important for guiding decisions that affect Earth's plant and animal life.

II Syllabus

UNIT-I Environmental chemistry 9h

Definition – Concept of Environmental chemistry-Scope and importance of environment in now a days – Nomenclature of environmental chemistry – Segments of environment–Effects of human activities on environment – Natural resources–Renewable Resources–Solar and Biomass Energy and Nonrenewable resources – Thermal power and atomic energy – Reactions of atmospheric oxygen and Hydrological cycle.

UNIT-II Air Pollution 9h

Definition – Sources of air pollution – Classification of air pollution – Ambient air quality standards- Climate change – Global warming – Pollution from combustion systems- Acid rain –Photochemical smog – Green house effect – Formation and depletion of ozone –

Bhopal gas disaster–Instrumental techniques to monitor pollution – Controlling methods of air pollution.

UNIT-III

Water pollution 9h

Unique physical and chemical properties of water – Water quality standards and parameters – Turbidity- pH Dissolved oxygen – BOD, COD, Suspended solids, total dissolvedsolids,alkalinity–Hardnessofwater–Methodstoconverttemporaryhardwaterintosoft water – Methods to convert permanent hard water into soft water – eutrophication and its effects –Industrial waste water treatment.

UNIT-IV

Chemical Toxicology 9h

Toxic chemicals in the environment – effects of toxic chemicals – cyanide and its toxic effects – pesticides and its biochemical effects – toxicity of lead, mercury, arsenic and cadmium- Solid waste management.

UNIT-V

Ecosystem and biodiversity 9h

Ecosystem : Concepts–structure–Functionsandtypesofecosystem– Abioticandbioticcomponents – Energy flow and Energy dynamics of ecosystem– Food chains – Food web– Tropic levels– Biogeochemical cycles (carbon, nitrogen and phosphorus)

Bio diversity:

Definition – level and types of biodiversity – concept- significance – magnitude and distribution of biodiversity–trends-biogeographical classification of india – biodiversity at national, global and regional level.

Suggested Co-Curricular Activities:

1) Training of students by related industrial experts.
2) Assignments, Seminars, Group discussions, Debates and Quiz(on related topics).
3) Visits to laboratories, firms, research organizations etc.

4) Invited lectures and presentations on related topics by field/industrial experts.

5) Preparation of videos on tools, techniques on selected topics.

I. List of Reference books:

1. Fundamentals of ecology by M.C.Dash
2. A Text book of Environmental chemistry byW. Moore and F.A. Moore
3. Environmental Chemistry by Samir k.Banerji
4. Water pollution, Lalude, MC Graw Hill
5. Environmental Chemistry, Anil Kumar De, Wiley Eastern ltd.
6. Environmental analysis, SM Khopkar (IIT Bombay)
7. Environmental Chemistry by BK Sharma & H Kaur, Goel publishing house.
8. Fundamentals of Environmental Chemistry, Manahan, Stanley. E
9. Applications of Environmental Chemistry, Eugene R. Wiener
10. Web related references suggested by teacher.

V - SEMESTER

Course 12 B Environmental Chemistry

Credits: 01

Environmental Chemistry

Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1. List out, Identify and handle various equipment in Chemistry lab.
2. Learn the procedures of preparation of standard solutions.
3. Demonstrate skills in operating instruments.
4. Acquire skills in handling spectrophotometer.
5. Analyze water and soil samples.

Laboratory course Syllabus:

1. Identification of various equipment in the laboratory.

2. Determination of carbonate and bicarbonate in water samples by double titration method.
3. Determination of hardness of water using EDTA

   a) Permanent hardness b) Temporary hardness
4. Determination of Chlorides in water samples by Mohr's method.
5. Determination of pH, turbidity and total solids in water sample.
6. Determination of Ca^{+2} and Mg^{+2} in soil sample by flame photometry.
7. Determination of pH in soil samples using pHmetry.

Suggested Co-Curricular Activities:

Mandatory:*(Lab /field training of students by teacher:(lab:10+field:05):*

1) For Teacher: Skills training of students by the teacher in classroom, lab and field for not less than15 hours on field related quantitative techniques for the water quality parameters, soil pollution and air pollution.

2) For Student: Individual visit to any one of the local field agencies/research laboratories in universities/research organizations/private sector culminating writing and submission of a handwritten fieldwork/project work Report not exceeding 10 pages in the given format.

3) Max marks for Field work / project work Report:05.

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5) Unit tests (IE).

II. List of Reference books:

1. A Text Book of Quantitative Inorganic Analysis(3^{rd}Edition) –A.I.Vogel
2. Water pollution, Lalude, MC Graw Hill
3. Environmental analysis, SM Khopkar (IIT Bombay)
4. Web related references suggested by teacher.

V - SEMESTER

Course 13A :Chromatography and Instrumental methods of Analysis

Credits: 03

Learning Outcomes:

1) Students after successful completion of the course will be able to:
2) Identify the importance of chromatography in the separation and identification of compounds in a mixture
3) Acquire a critical knowledge on various chromatographic techniques.
4) Demonstrate skills related to analysis of water using different techniques.
5) Understand the principles of spectrochemistry in the determination of metal ions.
6) Comprehend the applications of atomic spectroscopy.

Syllabus:

Unit-1: Chromatography-Introduction and classification (9 hours)

Principle, Classification of chromatographic methods, Nature of adsorbents, eluents, $R_f$values, factors affecting $R_f$values.

UNIT-2: TLC and paper chromatography (9hours)

Thin layer chromatography: Principle, Experimental procedure, preparation of plates, adsorbents and solvents, development of chromatogram, detection of spots, applications and advantages.

Paper Chromatography: Principle, Experimental procedure, choice of paper and solvents, various modes of development- ascending, descending, radial and two dimensional, applications.

UNIT-3: Column chromatography (9 hours)

Column chromatography: Principle, classification, Experimental procedure, stationary and mobile phases, development of the Chromatogram, applications.

HPLC: Basic principles, instrumentation–block diagram and applications.

UNIT-4: Spectrophotometry (9 hours)

Principle, Instrumentation : Single beam and double beam spectrometer, Beer-Lambert's law-Derivation and deviations from Beer-Lambert's law, applications of Beer-Lambert's law-Quantitative determination of Fe^{+2}, $Mn^{+2}$and Pb^{+2}.

UNIT-5: Polarimetry and Refractometry (9 hours)

Polarimetry and Refractometry: Polarimetry: Nature of polarized light, polarimeter, sample cells, operation of the polarimeter, optical purity. Refractometry; The refractive index, Refractometer.

Suggested Co-Curricular Activities:

1) Training of students by related industrial experts.
2) Assignments, Seminars and Quiz(on related topics).
3) Visits to laboratories, firms, research organizations etc.
4) Invited lectures and presentations on related topics by field/industrial experts

List of Reference books:

1) Fundamental so Analytical Chemistry by F.James Holler, Stanley R Crouch, Donald M.West and Douglas A.Skoog, Ninth edition, Cengage.
2) Analytical Chemistry by Gary D.Christian, Purnendu K.Dasgupta and Kevin A.Schug, Seventh edition, Wiley.
3) Quantitative analysis byR.A.DayJr .and A.L.Underwood,Sixth edition,Pearson.
4) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition/Pearson.
5) Instrumental methods of Chemical Analysis by Dr.B.K.Sharma 1981

V - SEMESTER

Course 13 A: Chromatography and Instrumental methods of Analysis

Credits: 01

Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1) Perform the separation of a given dye mixture using TLC
2) Learn the preparation of TLC plates
3) Demonstrate the separation of mixture of amino acids using paper chromatography
4) Acquire skills in using column chromatography for the separation of dye mixture.

Laboratory course Syllabus:

1) Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
2) Separation of mixture of methyl orange and methylene blue by column chromatography.
3) Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
4) Separation of food dyes using Column Chromatography
5) Separation of triglycerides using TLC
6) Verification of Beer lambert's law. (Using potassium permanganate solution) using colorimeter / spectrophotometer.

Co-Curricular Activities:

Mandatory: *(Lab /field training of students by teacher:(lab:10+field:05):*

1) **For Teacher**:Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of determination of hardness of water, using the calorimeter and or Spectrophotometer, preparation of TLC plate, identification of spots in TLC and Paper chromatographic techniques, loading of column, selection of solvent system, separation of amino acids and dyes mixture using chromatographic techniques.

2) For Student: Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the chromatographic techniques used for the separation of compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.

3) Max marks for Fieldwork/project work Report: 05**Max marks for Field work / project work Report:05.**

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5) Unit tests (IE).

List of Reference books:

1) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

2) VogelA.I .Practical Organic Chemistry, Longman Group Ltd.

3) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.

4) Ahluwalia V. K. and Agarwal R. Comprehensive Practical Organic Chemistry, University press.

5) MannF.Gand Saunders B.C, Practical Organic Chemistry, Pearson Education.

V - SEMESTER

Course 13 B Green Chemistry and Nanotechnology.

Credits: 03

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the importance of Green chemistry and Green synthesis.
2. Engage in Microwave assisted organic synthesis.
3. Demonstrate skills using the alternative green solvents in synthesis.
4. Demonstrate and explain enzymatic catalysis .
5. Analyse alternative sources of energy and carry out green synthesis.
6. Carry out the chemical method of nanomaterial synthesis.

II. Syllabus

UNIT-I Green Chemistry: I **9hrs**

Introduction-Definition of green Chemistry,Need for green chemistry, Goals of Green chemistry Basic principles of green chemistry. Green synthesis- Evaluation of the type of the reaction i) Rearrangements (100% atom economic),ii)Addition reaction(100% atom economic). Organic reactions by Sonication method: apparatus required and examples of sono chemical reactions (Heck, Hundsdiecker and Wittig reactions).

UNIT- II Green Chemistry : Part- II **9hrs**

A) Selection of solvent:

i) Aqueous phase reactions

ii) Reactions in ionic liquids, Heck reaction, Suzuki reactions,epoxidation.
iii)Solid supported synthesis

B) Supercritical CO_2:Preparation, properties and applications,(decaffeination, drycleaning)

C) Green energy and sustainability.

UNIT-III Microwave and Ultrasound assisted green synthesis: 9hrs

Apparatus required, examples of MAOS (synthesis of fused anthroquinones, Leukart reductive amination of ketones)-Advantages and disadvantages of MAOS. Aldol condensation –Cannizzaro reaction - Diels-Alder reactions- Strecker's synthesis

UNIT-IV Green catalysis and Green synthesis 9hrs

Heterogeneous catalysis, use of zeolites, silica, alumina, supported catalysis-biocatalysis: Enzymes, microbes Phase transfer catalysis (micellar/surfactant)

1. Green synthesis of the following compounds : adipic acid, catechol, disodium imino diacetate (alternative Strecker's synthesis)

2. Microwave assisted reaction in water –Hoffmann elimination – methyl benzoate to benzoic acid – oxidation of toluene and alcohols–microwave assisted reactions in organic solvents. Diels-Alder reactions and decarboxylation reaction.

3. Ultrasound assisted reactions–sonochemical Simmons–Smith reaction(ultrasonic alternative to iodine)

UNIT – V Nanotechnology in Green chemistry 9hrs

Basic concepts of Nanoscience and Nanotechnology – Bottom-up approach and Top down approaches with examples – Synthesis of Nano materials – Classification of Nanomaterials – Properties and Application of Nanomaterials. Chemical and Physical properties of Nanoparticles – Physical synthesis of nanoparticles – Inert gas condensation - aerosol method

- Chemical Synthesis of nanoparticles – precipitation and co-precipitation method, sol-gel method.

III. Suggested Co-Curricular Activities:

1) Training of students by related industrial experts.

2) Assignments, Seminars, Group discussions, Debates and Quiz(on related topics).

3) Visits to laboratories, firms, research organizations etc.

4) Invited lectures and presentations on related topics by field/industrial experts.

5) Preparation of videos on tools, techniques and applications of Green chemistry and Nanosynthesis.

IV. List of Reference books:

1. Green Chemistry Theory and Practical. P.T.Anatas and J.C. Warner
2. Green Chemistry V.K. Ahluwalia Narosa, New Delhi.
3. Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
4. Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
5. Principles and practice of heterogeneous catalysis, Thomas J.M.,Thomas M.J., John Wiley
6. Green Chemistry: Environmental friendly alternatives R S Sanghli and M.M Srivastava, Narosa Publications
7. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press (2008).
8. Green Processes for Nanotechnology: From Inorganic to Bioinspired Nanomaterials, Vladimir A. Basiuk, Elena V. Basiuk Springer (2015)
9. Web related references suggested by teacher.

V- SEMESTER

Course 13 B Green Chemistry and Nanotechnology

Credits: 01

V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1. List out, identify and handle various equipment in the laboratory.
2. Learn the procedures of green synthesis.
3. Demonstrate skills in the preparation of Nanomaterials.
4. Acquire skills in Microwave assisted organic synthesis.
5. Perform some applications of Nanomaterials.

VI. Laboratory course Syllabus:

1. Identification of various equipment in the laboratory.
2. Acetylation of 1^0 amine by green method: Preparation of acetanilide
3. Rearrangement reaction in green conditions: Benzil - Benzilic acid rearrangement
4. Radical coupling reaction: Preparation of 1,1-bis -2-naphthol
5. Green oxidation reaction: Synthesis of adipic acid
6. Preparation and characterization of biodiesel from vegetable oil/ waste cooking oil
7. Preparation and characterization of Nanoparticles of gold using tea leaves.
8. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
9. Photoreduction of Benzophenone to Benzopinacol in the presence of sunlight.

VII. Suggested Co-Curricular Activities:

Mandatory:*(Lab /field training of students by teacher:(lab:10+field:05):*

1) **For Teacher**: Training of students by the teacher in the classroom or in the laboratory for not less than 15 hours on field related quantitative techniques for Enzymatic catalysis, Microwave assisted organic synthesis, Biodiesel preparation etc

2) **For Student**: Student shall visit a related industry / chemistry laboratory in universities / research organizations/private sector facility and observe various methods used for the analysis of water. Write their observations and submit a hand written fieldwork /project work report not exceeding10pages in the given format to the teacher.

3) Max marks for Field work / project work Report:05.

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5) Unit tests (IE).

VIII. List of Reference books:

1) Green Chemistry Theory and Practical. P.T.Anatas and J.C. Warner

2) Green Chemistry V.K. Ahluwalia Narosa, New Delhi.

3) Real world cases in Green Chemistry M.C. Cann and M.E. Connelly

4) Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)

5) Web related references suggested by teacher.

V - SEMESTER

Course 14A: Synthetic Organic Chemistry.

Credits: 03

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1) Identify the importance of reagents used in the synthesis of organic compounds.
2) Acquire knowledge on basic concepts in different types of pericyclic reactions.
3) Understand the importance of retro synthesis inorganic chemistry.
4) Comprehend the applications of different reactions in synthetic organic chemistry.

II. Syllabus:

Unit-1:Pericyclic reactions 9 hours

Definition and classification of pericyclic reactions: Phases, nodes and symmetry properties of molecular orbital's in ethylene,1,3-butadiene,1,3,5-hexatriene,alkylationandallylradical. Thermal and photochemical reactions. Electro cyclic reactions: Definition and examples, definitions of con and disrotation,Woodward-Hoffmann selection rules.(Correlation diagrams excluded) Cyclo addition reactions: Definition and examples, definitions of supra facial and antar facial addition, Woodward- Hoffmann selection rules. (Correlation diagrams excluded)

Unit-2 : Organic photochemistry 9hours

Jablonski diagram-singlet and triplet States Photochemistry of Carbonyl compounds $n{-}\pi^*$ and $\pi{-}\pi^*$transitions, Norrish type-1and type-2reactions Paterno–Buchi reaction.

Unit-3 : Retrosynthesis 9 hours

Important terms in Retro synthesis with examples-Disconnection, Target molecule, FGI, Synthon, Retrosynthetic analysis, chemo selectivity, region selectivity. Importance of Order of events in organic synthesis. Retrosynthetic analysis of the compounds: a) cyclohexene b)4-Nitro toluene c) Paracetamol.

Unit-4 : Synthetic Reactions 9 hours

Shapiro reaction, Stork - enamine reaction(only alkylation),Wittig reaction, Robinson annulation, Bailys-Hillman reaction, Heck reaction, Suzuki coupling. Synthesis of aldehydes and ketones using1, 3-Dithiane.

Unit-5 : Reagents in Organic Chemistry 9 hours

Oxidizing agents:PCC,PDC,SeO_2 (Riley oxidation), NBS.

Reducing agents : $LiAlH_4$(with mechanism), LTBA, Metal-solvent reduction (Birch reduction), Catalytic reduction.

III. Suggested Co-Curricular Activities:

1) Training of students by related industrial experts.
2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3) Visits to laboratories, firms, research organizations etc.
4) Invited lectures and presentations on related topics by field / industrial experts.

IV. List of Reference books:

1) Pericyclic reactions by Ian Fleming, Second edition,Oxford University press.
2) Pericyclic Reactions- A Text book: Reactions, Applications and Theory by S.Sankararaman, WILEY-VCH.
3) Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P.Singh, Revised edition, Trinity Press.
4) Pericyclic reactions – A Mechanistic study by S.M.Mukherji, Macmillan India.
5) Organic synthesis :The disconnection approach by Stuart Warren, John Wiley&Sons.
6) Organic chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren, Second edition, Oxford university press.
7) Reactions, Reagents and Rearrangements by S.N. Sanyal, Bharati Bhawan Publishers &Distributors

V - SEMESTER

Course - 14-A Synthetic Organic Chemistry

Credits: 01

V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1) Perform the organic qualitative analysis for the detection of N, S and halogens using the green procedure.
2) Learn the procedure for the separation of mixture famine acids using paper Chromatography.
3) Prepare the TLC plates for TL chromatography.
4) Acquire skills in conducting column chromatography for the separation of dyes in the given mixture.

VI. Laboratory course syllabus:

1) Green procedure for organic qualitative analysis: Detection of N,S and halogens
2) Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
3) Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
4) Separation of mixture of methyl orange and methylene blue by column chromatography
5) Separation of food dyes using Column Chromatography
6) Separation of triglycerides using TLC

VII. Suggested Co-Curricular Activities

1) Mandatory:*(Lab/field training of students by teacher:(lab:10+field:05*):
2) For Teacher: Training of students by the teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of detection of N, Sand halogens using thegreen procedure, preparation of TLC plates, detection of organic compounds using Rf values in TLC / paper chromatography, loading of column, selection of solvent

system for column chromatography, separation of amino acids and dye mixture using chromatographic techniques.

3) For Students : Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the synthetic reactions. Write their observations and submit a hand written fieldwork/project workreportnotexceeding10 pages in the given format to the teacher.

4) Max marks for Fieldwork/project work Report:05.

5) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*

6) Unit tests(IE).

VIII. List of Reference books :

1) VogelA.I.Practical Organic Chemistry, Longman Group Ltd.

2) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.

3) Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, University press.

4) MannF.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

V - SEMESTER

- Course 14 B:Industrial Chemistry- Fertilisers and Surface coatings

Credits: 03

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1) Identify the importance of different surface coatings.
2) Acquire a critical knowledge on manufacture of ceramics and cement.
3) Understand various steps in the manufacture of cane sugar.
4) Explain the manufacture of pulp and paper.

II. Syllabus:

Unit-1: Fertilizers 9 hours

A brief introduction to industrial chemistry. Different types of fertilizers. Manufacture of the following fertilizers :Urea, Ammonium nitrate, Calcium ammonium nitrate, Ammonium phosphates; Polyphosphate, Superphosphate, Compound and mixed fertilizers.

Unit-2: Silicates 9 hours

Ceramics: Important clays and Feldspar. Ceramics - types, uses and manufacture. High technology ceramics and their applications.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit-3 : Surface Coatings 9 hours

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments - formulation, composition and related properties. Oil paint

,modified oils, Pigments, toners and lake pigments, fillers, thinners, enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Water and Oil paints.

Unit-4: Sugar Chemistry 9hours

Introduction – Manufacture and recovery of cane sugar from molasses, manufacture of sucrose from beet root, testing and estimation of sucrose.

Unit-5: Paper Industry 9 hours

Pulp and Paper-Introduction, Manufacture of pulp, sulphate or Kraft pulp, soda pulp, sulphite pulp, rag pulp, beating, refining, filling, sizing and colouring of pulp, manufacture of paper.

III. Suggested Co – Curricular Activities:

1) Training of students by related industrial experts.

2) Assignments, Seminars, debates , discussions and Quiz(on related topics).

3) Visits to industries, firms, research organizations etc.

4) Invited lectures and presentations on related topics by field/industrial experts.

5) Preparation of PPTS and videos.

IV. List of Reference books:

1) J.A.Kent : Riegel's Hand book of Industrial Chemistry, CBS Publishers, New Delhi.

2) P.C.Jain, M.Jain : Engineering Chemistry, Dhanpat Rai & Sons, Delhi.

3) R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.

4) B.K.Sharma: Engineering Chemistry,Goel Publishing House,Meerut

5) O. P. Vermani, A. K. Narula: Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi.

V - SEMESTER

Course - 14-B Industrial Chemistry- Fertilizers and Surface coatings

Credits: 01

V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1) Determine free acidity in ammonium sulphate fertilizer.
2) Learn the procedure for the Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3) Demonstrate skills on Estimation of phosphoric acid in superphosphate fertilizer.
4) Acquire skills in using colorimeter for the estimation of sucrose.

VI. Laboratory course Syllabus:

1) etermination of free acidity in ammonium sulphate fertilizer.
2) Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3) Estimation of phosphoric acid in superphosphate fertilizer.
4) Estimation of sucrose by colorimetry.

VII. Suggested Co-Curricular Activities:

Mandatory:*(Lab / field training of students by teacher :(lab:10+field:05):*

1) For Teacher: Training of students by the teacher in laboratory and field for not less than 15hours on field related skills in determination of free acidity, estimation of calcium and phosphoric acid in a fertilizer, use of colorimeter to estimate sucrose.

2) For Student :Student shall visit a related industry /chemistry laboratory in universities/research organizations/private sector facility and observe the surface coatings of surfaces used to prevent the corrosion. Write their observations and submit a hand written fieldwork/project work report notexceeding10pagesinthe given format to the teacher.

3) Max marks for Field work/ project work Report:05.

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5) Unit tests(IE).

VIII. List of Reference books:

1) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

2) Text book on Experiments and Calculations in Engineering Chemistry, S.S.Dara, S.Chand.

3) R.Gopalan, D.Venkappayya, S.Nagarajan: Engineering Chemistry,Vikas Publications.

4) B.K.Sharma: Engineering Chemistry, Goel Publishing House, Meerut

V - SEMESTER

Course 15 A Analysis of Organic Compounds

Credits: 03

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1) Identify the importance of mass spectrometry in the structural elucidation of organic compounds.
2) Acquire the knowledge on structural elucidation of organic compounds.
3) Understand various chromatography methods in the separation and identification of organic compounds.
4) Demonstrate the knowledge gained in solvent extraction for the separate the organic compounds.

II. Syllabus:

Unit-I: Nuclear Magnetic Resonance (NMR) spectroscopy 9 h

Principles of nuclear magnetic resonance, equivalent and non-equivalent protons, position of signals. Chemical shift, NMR splitting of signals - spin-spin coupling, coupling constants. Applications of NMR with suitable examples - ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromo ethane, ethyl acetate, toluene and acetophenone.

Unit II Mass Spectrometry 9hrs

A brief introduction to analysis of organic compounds

Basic principles, Instrumentation - Mass spectrometer, electron Ionization (Electron Impactionization, EI), Molecular ions, metastable ions, Isotope abundance. Basic fragmentation types. Fragmentation patterns in Toluene, 2-Butanol, Butaldehyde, Propionicacid.

Unit-III : Structural elucidation of organic ompounds using IR,NMR & mass spectral data- 9 hours

2,2,3,3-Tetramethyl butane,Butane-2,3-dione,Propionicacid and methyl propionate.
Phenyl acetylene, acetophenone, cinnamic acid and p-nitroaniline.

Unit-IV: Separation techniques-1 9 hours

Solvent extraction-Principle and theory, Batch extraction technique, application of batch extraction in the separation of organic compounds from mixture- acid & neutral, base & neutral.

Chromatography – Principle and theory, classification, types of adsorbents, eluents, Rfvalues and factors affecting Rfvalues. Thin layer chromatography - principle, experimental procedure, advantages and applications.

Unit-5: Separation techniques - 2 9 hours

Paper chromatography- Principle, experimental procedure, ascending, descending, radial and two dimensional, applications.

Column chromatography - Principle, classification, experimental procedure and applications.
HPLC-Principle, Instrumentation – block diagram and applications.

III. Suggested Co-Curricular Activities:

1) Training of students by related industrial experts.

2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.

3) Visits to laboratories, firms, research organizations etc.

4) Invited lectures and presentations on related topics by field / industrial experts.

IV. List of Reference books:

1) Organic Spectroscopy by William Kemp,Third Edition, Palgrave USA.

2) Introduction to Spectroscopy by Pavia, Lamp man, Kriz and Vyvyan, Fifth edition, Cengage.

3) Organic Spectroscopy: Principles and Applications by Jag Mohan, Second edition, Alpha Science.

4) Spectroscopy of Organic Compounds by P.S.Kalsi, Seventh edition, New Age

International.

5) Spectroscopic Methods in Organic Chemistry by Ian Fleming and Dudley Williams, Seventh edition, Springer.

6) Fundamentals of Analytical Chemistry by F.James Holler, Stanley R Crouch, Donald M.West and Douglas A.Skoog, Ninth edition, Cengage.

7) Analytical Chemistry by Gary D.Christian, Purnendu K.Dasgupta and KevinA.Schug, Seventh edition, Wiley.

8) Quantitative analysis by R.A.DayJr.andA.L.Underwood, Sixth edition, Pearson.

9) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

V - SEMESTER

Course – 15 A Analysis of Organic Compounds

Credits: 01

V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1) Prepare acetanilide using the green synthesis.
2) Demonstrate the preparation of an azo dye.
3) Acquire skills in the separation of organic compounds in the given mixture using solvent extraction

VI. Laboratory course Syllabus:

1) Identification of various equipment in the laboratory.
2) Acetylating of 1^0amine by green method : Preparation of acetanilide
3) Rearrangement reaction in green conditions : Benzil-Benzilic acid rearrangement
4) Radical coupling reaction : Preparation of 1,1-bis-2-naphthol
5) Green oxidation reaction: Synthesis of adipic acid
6) Preparation and characterization of biodiesel from vegetable oil/waste cooking oil.
7) Photo reduction of Benzophenone to Benzopinacol in the presence of sunlight.
8) Separation of organic compounds in a mixture(acidic compound + neutral compound) using solvent extraction.
9) Separation of organic compounds in a mixture (basic compound+ neutral compound) using solvent extraction.

VII. Suggested Co-Curricular Activities:

Mandatory: *(Lab / field training of students by teacher:(lab:10+field:05):*

1) For Teacher: Training of students by teacher in laboratory and field for not lessthan15 hours on the field techniques/skills of preparation of acetanilide, preparation of azo dye, use of separating funnel for solvent extraction, separation of organic compounds in a mixture.

2) For Student : Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the techniques used for the separation of organic compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding10 pages in the given format to the teacher.

3) Max marks for Fieldwork / project work Report:05.

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*

5) Unit tests(IE).

VIII. List of Reference books :

1) Vogel A.I.Practical Organic Chemistry, Longman Group Ltd.

2) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.

3) Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, University press.

4) MannF.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

V - SEMESTER

Course 15 B : Industrial Chemistry- Polymers and water analysis

Credits: 03

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1) Understand the basic concepts of polymers
2) Acquire a critical knowledge on the preparation and applications of organic polymers.
3) Explain the sources of air pollution.
4) Demonstrate the analysis of water quality parameters.
5) Identify the importance of industrial waste management.

II. Syllabus:

Unit-1: Organic Polymers-1 9 hours

Basic definitions, degree of polymerization, classification of polymers-Natural and Synthetic polymers, Organic and Inorganic polymers, Thermo plastic and Thermosetting polymers, Plastics, Elastomers, Fibers and Resins, Linear, Branched and Cross-Linked polymers.

Unit-2: Organic Polymers-2 9 hours

Addition polymers and Condensation polymers, mechanism of polymerization- Free radical, ionic and Zeigler-Natta polymerization. Industrial manufacturing and applications of following polymers, Polystyrene, Poly acrylo nitrile, Poly methacrylate, Polymethyl- methacrylate.

Unit-3: Air Pollution 9 hours

Sources of air pollution, acid rain, photochemical smog, Greenhouse effect, Formation and depletion of ozone, sources and effects of various gaseous pollutants: NO_x, SO_x, SPM, CO, hydrocarbons, controlling methods of air pollution.

Unit-4 Analysis of water 9hours

Determination of total hardness of water, Dissolved oxygen, BOD, COD, total dissolved solids, turbidity, alkalinity, determination of chloride using Mohr's method.

Unit-5 : Industrial Waste Management 9 hours

Waste water treatment - primary, secondary & tertiary treatment. (All treatment methods in detail). Characteristics of solid wastes, methods of solid waste treatment and disposal, microbiology involved in solid waste disposal, methods of solid waste disposal-composting, sanitary and filling - economic, aesthetic and environmental problems.

III. Suggested Co- Curricular Activities

1) Training of students by related industrial experts.
2) Assignments, Seminars, discussions and Quiz(on related topics).
3) Visits to laboratories, firms, research organizations etc.
4) Invited lectures and presentations on related topics by field / industrial experts.

IV. List of Reference books :

1) E.Stocchi: Industrial Chemistry,Vol-I,Ellis Horwood Ltd. UK
2) J.A.Kent : Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
3) P.C.Jain, M.Jain : Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
4) R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
5) B.K.Sharma : Engineering Chemistry, Goel Publishing House, Meerut
6) O.P.Vermani, A.K.Narula: Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi.
7) A.K.De, Environmental Chemistry : NewAgeInternational Pvt, Ltd, NewDelhi.
8) C.k.Varshney:Water Pollution and Management,Wiley Eastern Limited, Chennai.
9) S.S. Dara and D.D. Mishra: Text book of Environmental Chemistry and Pollution Control, Revised edition, S.C.Hand & CoLtd.

V -SEMESTER

Course – 15- B Industrial Chemistry- Polymers and water analysis

Credits: 01

V. Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1) Learn the procedures for the determination of BOD and COD.
2) Demonstrate skills in the determination of chloride in the given water sample.
3) Acquire skills in determining the hardness of water.
4) Analyse the soil samples
5) Handle pHmeter.

VI. Laboratory course Syllabus:

1) Determination of Hardness of water by EDTA titration.
2) Determination of Chemical Oxygen Demand(COD)
3) Determination of Biological Oxygen Demand(BOD)
4) Determination of chloride using Mohr's method.
5) Determination of pH, turbidity and total solids in water sample.
6) Determination of Ca^{+2} and Mg^{+2} in soil sample by flame photometry.
7) Determination of pHin soil samples using pHmetry.

VII. Suggested Co-curricular activities

Mandatory:*(Student training by teacher in field related skills:inlab:15,in field:05hours):*

1) For Teacher: Training of students by the teacher in laboratory and field for not lessthan15hours on the field related skills in the determination of hardness of water, estimation of COD and BOD in water sample, determination of chloride ion in water sample.

2) For Student: Student shall visit a related industry /chemistry laboratory in universities/research organizations /private sector facility and observe the measurement of water quality parameters. Write their observations and submit a hand written field work / project work report not exceeding10pages in the given format to the teacher.

3) Max marks for Fieldwork/project work Report:05.

4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations ,findings, and acknowledgements.*

5) Unit tests(IE).

VIII. List of Reference books :

1) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

2) Text book on Experiments and Calculations in Engineering Chemistry, S.S.Dara, S.Chand.

Note-1: For SEMESTER –VII &VIII, for the domain subject Chemistry, Three Core courses and Two Skill Enhanced Courses shall be chosen course A or B from the list of Courses in each SEMESTER. Three pairs of Core Courses are 16A&16B, 17A&17B, 18A&18B for Sem- VII and 21A &21 B, 22 A& 22 B and 23 A& 23 B in Sem-VIII.

Two Pairs of Skill Enhanced Courses are 19A&19B, 20A&20 B for Sem-VII and 24A & 24 B, 25A&25 B from Sem- VIII

One Online Course chosen from Swayam/NPTEL/Any other courses recognized by universities per SEMESTER -VII and VIII.

Note-2: *One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the skills embedded in syllabus citing related real field situations.*