M.Sc. Industrial Chemistry

Syllabus

Semester I

Paper I (MSIC – 101) - Analytical Techniques Part A

Unit I

Basics of Filtration processes

Introduction to unit processes and unit operations, Screening, Mixing, Coagulation and Flocculation, Sedimentation: Type of settling, Filtration for wastewater treatment. Type of filters - rapid sand filter, slow sand filter, high rate filter, pressure filter. Gravitational settling, Centrifugal impaction, Inertial impaction, Diffusion, Electrostatic precipitation,

Unit II

Electron Microscopy

Introduction, Principle and Instrumentation of SEM and TEM.

Unit III

Separation Techniques

Solvent extraction (liquid-liquid extraction), general principles, relationship between extraction and distribution coefficient, distribution ratio, multiple extractions, extraction of metal organic complexes and ion association complexes.

Unit IV

Chromatographic Techniques

Classification, basic principles, theory of chromatography, Ion-exchange chromatography: ion exchange process, synthesis and structure of ion-exchange resin, resolution, retention parameters, ion-exchange capacity and separation of lanthanides; Paper and thin-layer chromatography, various techniques of development, visualization and evaluation of chromatograms, Liquid-gas chromatography, HPLC: introduction, methodology, instrumentation and industrial application.

Recommended Text Books:

1. *Vogel's Textbook of Quantitative Chemical Analysis, Bassette and co-workers, Longman Group UK*
2. *Fundamentals of molecular spectroscopy, Banwell, C.N.*
3. *Instrumental methods of analysis, Willard M.H., Merrit, L.L., Dean J.A., Settle, F.A.*
4. *Principles and practice of analytical chemistry, Fifield F.W., Kaley D., Blackie Academic and Professional, 4th Edition, 1995.*

22/5/19 22.5.19 22/5/19 22/5/19 22/05/19 22/5/19

Paper II (MSIC– 102) - Research Methodology, Statistical Techniques and Computer Applications

Unit I

Basics of Research Methodology

Introduction to research methodology and design, research definition, selection and formulation of research problem, types of research, formulation of hypothesis, review of literature, types of data- primary, secondary and tertiary data, research process, survey and census

Unit II

Sampling Techniques

Population and sample, Sampling theory and techniques, advantages and limitations of sampling, data collection, coding and tabulation, probability and non probability sampling techniques, field research methodology

Unit III

Central Tendency

Measures of central tendency: mean, mode, median, data distribution, Chebyshev's theorem, variance, standard deviation, standard error, ratio and proportion, precision and accuracy, correlation, rank correlation, significance level, t-test, paired t-test

Unit IV

Statistical Tests

Non-parametric tests: Chi square test for goodness of fit and relationship between two variables, Analysis of variance. F-test, Data presentation: Charts, graphs

Unit V

Fundamentals of Computer Organization and Applications

Fundamentals of computers, Computer organization, binary numbers, flow chart, Use of data analysis tools and text editors, power point presentations, different templates for report writing and dissertations, use of computers in report preparation and presentation

Recommended Text Books:

1. *Statistical Methods- S.P.Gupta*
2. *Research Methodology, Methods and Techniques- C.P.Kothari*
3. *Statistics (Theory and Practice) – B.N.Gupta*
4. *Research Methodology Methods and statistical Techniques- Santosh Gupta*
5. *Research Methodology and statistical Measures- Reddy and Rao*
6. *Research Methodology- Sharma and Jain.*

Paper V (MSIC – 105) - Lab Course I

1. Determination of total acidity/ alkalinity of given water sample.
2. To determine the total hardness of water.
3. Determination of chloride content of a water sample by Mohr`s method.
4. Purification and distillation of tap water / organic solvent.
5. Preparation of phenol formaldehyde resin.
6. To separate the given organic compounds mixture by TLC / Paper chromatography.
7. To separate the different organic compounds by column chromatography.
8. To Prepare 2, 4, 6 – tribromo aniline.
9. To prepare phthalamide from phthalic anhydride.
10. To determine the relative viscosities of given liquids by Ostwald viscometer.
11. Determination of brix, specific gravity and pH of molasses.
12. Determination of total reducing sugar in molasses by Lane & Eynon method.
13. Determination of RS Brix / Pol/ Purity and RS (reducing sugar) in sugar.
14. Conductometric titrations of different acid-base mixtures.
15. Determination of CMC (critical micelle concentration) of a surfactant in water by surface tension measurements at different concentrations.

Semester II

Paper VII (MSIC – 201) - Polymer Chemistry

Unit I

Basic Concepts, Kinetics and Rheology

Polymers and their classification, nomenclature, Types of Polymerization: condensation, addition (free radical, cationic and anionic), copolymerization, Kinetics, Polydispersity and Molecular weight distribution, practical significance and measurement of molecular weight

Unit II

Thermodynamics and Transition properties of polymer

Glass transition temperature in polymers (T_g), Melt transition (T_m), factors influencing glass transition temperature, relationship between T_g and T_m

Process of Polymer dissolution, The Flory –Higgins Theory of polymer dissolution

Unit III

Polymer Processing

Plastics, Elastomers and Fibres, Processing techniques: calendaring, casting, moulding, thermoforming, foaming, reinforcing and fiber spinning, film and laminates. Manufacturing of Thermocol.

Unit IV

Commercially Important Polymers and Applications

Commercially important Thermosetting and Thermoplastic polymers, Resins: Phenol- Formaldehyde resins, Urea- Formaldehyde resins, Epoxy resins, Melamine-Formaldehyde resins. Biomedical polymers, electrically conducting polymers, smart polymers

Recommended Text Books

1. *Fried JR, Polymer Science and Technology, Prentice-Hall of India,(2000)*
2. *Billmeyer F.W., Textbook of Polymer Science, Wiley-Interscience: New York (1984)*
3. *DeGennes, P.G. Scaling Concepts in Polymer Physics, Cornell University Press (1979)*
4. *Young R.J. & Lovell, P.A., Introduction to Polymers 2nd Ed., Champan & Hall (1991)*

Paper VIII (MSIC–202)- Chemistry of Materials, Petrochemicals and Fertilizers

Unit I

Cement, Composites, Ceramic and Glass

Composition of cement, mixing of cement clinker with Gypsum, Setting of cement. Microscopic and Macroscopic Composites, Dispersion, Strengthened, Particle and Fiber- reinforced Composites. Composition, Physical and Chemical properties of Glass, Varieties of glass, Introduction to ceramics

Unit II

Magnetic and Nanomaterials

Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Hysteresis, Remanence and Coercivity, Design of Molecular- based magnets: Three dimensional magnetic ordering. Preparation, Properties, Characterization and Applications of Nano materials (SEM, TEM).

Unit III

Fertilizers

N - Ammonia, Ammonium nitrate and Urea; P - Phosphoric acid, Single and Triple superphosphate, DAP; K- Potassium Nitrate and Muriate of potash.

Unit IV

Petrochemicals and Lubricants

Introduction, Occurrence, Composition of Petroleum, Natural gas, cracking, refining, octane rating, cetane number, flash and fire point determination.

Lubricating oils and additives, Naphtha crackers and Profile of their products, Synthetic and Blended oils.

Recommended Text Books

1. *Oliver Kahn. Molecular Magnetism. VCH Publishers, (UK).*
2. *W. D. Callisters. Materials Science and Engineering: An Introduction, Wiley.*
3. *N. W. Aschcroft and N. D. Mermin. Solid State Physics,*
4. *J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rowlings. Materials Science. ELBS.*
5. *Kelker and Hatz. Hand Book of Liquid Crystals*

Paper IX (MSIC – 203) - Analytical Techniques Part B

Unit I

Spectroscopic Techniques

Introduction, Principles, Instrumentation and Application of IR, UV- Visible, NMR and Mass spectroscopy

Unit II

Electron Spin Resonance

Introduction, Technique, Instrumentation and Applications of ESR.

Unit III

Polarography

Origin of polarography, Current-voltage relationship, Theory of polarographic waves (DC and sampled D polarograms), Instrumentation, Qualitative and Quantitative applications.

Unit IV

X-ray Diffraction

Introduction, Bragg's law, Miller indices, Instrumentation and its applications.

Recommended Text Books

1. Hollas, J. M. Modern Spectroscopy 4th Ed., John Wiley & Sons (2004).

2. Kemp, W. Organic Spectroscopy 3rd Ed., W. H. Freeman & Co.(1991).

3. Silverstein, R. M., Bassler, G. C. & Morrill, T. C. Spectroscopic Identification of Organic Compound, John Wiley & Sons (1981)

4. Ebsworth, E. A. O. Structural Methods in Inorganic Chemistry Blackwell Scientific Publications (1991).

5. Drago, R. S. Physical Methods in Chemistry, W.B. Saunders Co., U.K. (1977)

Paper X (MSIC –204) - Environmental Chemistry and Wastewater Management

Unit I

Basics of Sustainable Development

Scope and Importance of environmental studies, Need for public awareness, Segments of environment, biodiversities: Genetic diversity, Species diversity, Ecosystem diversity, Landscape diversity, Causes of pollution and detrimental effects, Eco systems- Types of ecosystems, energy flow in an ecosystem, Balanced ecosystem, Basics of Environmental Impact Assessment, Sustainable Development

Unit II

Energy Resources and Air Pollution

Energy- Different types of energy (Renewable and Non-renewable), Conventional and non- conventional energy sources- Electromagnetic radiation, Hydro Electric, Fossil fuel based, Nuclear, Solar, Biomass and Bio-gas, Hydrogen as an alternative future source of energy.Environmental pollution and their effects, Water pollution , Land Pollution , Noise Pollution, Public Health aspects , Air pollution. Current environmental issues of importance and their impact on environment: Population Growth, Climate change and global warming effect, Urbanization, Automobile pollution. Acid rain , Ozone layer depletion.

Unit III

Water Quality Assessment and Treatment

Water quality assessment by DO, COD, BOD, TDS, TSS and dissolved ions determination. Hardness of water, softening of water, Reverse osmosis, Treatment of boiler feed water by Calgon process, Ion-exchange resins and Zeolites

Unit IV

Disinfection of Water

Chemical unit processes for Wastewater treatment

Disinfection: Objectives, Different Types - Bleaching Powder, Ozone Treatment, UV Irradiation, Chlorination – Types, Breakpoint chlorination, Dechlorination

Unit V

Advanced Water Treatment Techniques

Advanced treatment operations, Adsorption Isotherms, Advanced Oxidation Process, Membrane processes, Reverse osmosis, Electro dialysis, Desalination, Ion exchange: Removal of specific chemical contaminants as fluorides, arsenic, nitrates and organics.

Recommended Text Books

1. *Environment and Ecology, Gupta K.M., Umesh Publications, Delhi, 2008.*
2. *Perspectives in Environmental Studies, Kaushik A, Kaushik CP, New Age International Publishers, 2014.*
3. *Environmental Engineering Science, Nazaroff W.W., Alvarez-Cohen L., Wiley India Pvt. Ltd., 2004.*
4. *Wastewater Engineering: Treatment and Reuse, Metcalf and Eddy, Fourth Edition, Tata McGraw Hill.*

Paper XI (MSIC – 205) - Industrial Training and Seminar Part A

Minimum 2-3 weeks training at an industry during summer

Report to be submitted after training.

Presentation of work done and things learnt at training in the coming semester.

Semester III

Paper XIII (MSIC – 301) - Natural Products, Cosmetics and Perfumery

Unit I

Carbohydrates

Disaccharides and Polysaccharides (Maltose, Cellulose, Lactose and Sucrose)

Unit II

Natural Products

A general introduction, isolation, synthesis and structure of

Alkaloids: Nicotine, Morphine.

Terpenoids: Camphor, Menthol,

Steroids: Cholesterol and Ergocalciferol

Flavonoids: Quercetin and Kaempferol.

Unit III

Cosmetics

Raw materials, Cosmetics for Skin (toners, cleansing agents, moisturizers, sunscreens, talcum powder, bleaching products) and Hair Cosmetics (shampoos, conditioner, colorants, herbs used in hair cosmetics).

Unit IV

Perfumes

Introduction, Composition and Extraction of Perfume (flowers, clove, heena and rice bran) and Identification of compounds used in perfumery.

Recommended Text Books:

1. *Carey, F.A. & Sundberg, R.J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).*
2. *Carruthers, W. Modern methods of Organic Synthesis, Cambridge University Press (1971).*
3. *Warren, S. Organic Synthesis: The Disconnection Approach, John Wiley & Sons (1984).*
4. *J. March. Advanced Organic Chemistry, Reaction Mechanisms and Structure, John Wiley.*
5. *W. Carruthers .Some Modern Methods of Organic Synthesis, Cambridge University Press.*
6. *I. L. Finar, Organic Chemistry, ELBS, U.K.*
7. *Morrison R.T. & Boyd R. N.; Organic Chemistry, Prentice Hall India.*
8. *Clayden, J.; Organic Chemistry, Oxford University Press.*

Paper XIV (MSIC – 302) - Pharmaceutical Chemistry

Unit I

Basics of Pharmaceutical Chemistry

Introduction: Characteristics of drug, Common drug targets, Efficacy, inhibitory concentration, lethal dose, therapeutic index, half life, pass time and frequency of dosing, agonists, antagonists, competitive and non competitive inhibitors

Unit II

Drug Synthesis and Testing Techniques

In vitro testing, Line-Weaver-Burk Plot, Pharmacokinetics and pharmacodynamics, ADME, biological testing, natural and synthetic lead compounds, combinatorial synthesis, stereochemistry considerations and optimizing reactions

Unit III

Structure - Activity Relationships

Quantitative structure-activity relationships, Pharmacophore: skeletal and non-skeletal, substrate based drug design and target based drug design, Case study

Unit IV

Antibiotics

Synthesis of selected antibiotics, Structure, activity, resistance issues,

Different classes of antibiotics: Cephalosporins, Penicillins and other beta lactam antibiotics, Fluoroquinolones and other synthetic antibiotics

Unit V

Advanced Therapeutics Techniques

Strategies in design of Anticancer and anti-HIV drugs, Cytotoxicity and bioavailability issues, Drug delivery systems, Gene therapy, Immunotherapy

Unit VI

Important Drug Categories

Psychoactive drugs and cardiovascular drugs

Recommended Text Books

1. *Foye's Principles of Medicinal Chemistry, Williams, D.A., Lemke, T.L., Lippincott Williams and Wilkins, 2005.*
2. *Medicinal Chemistry, Kar, A., New Age International Publishers, 2007.*
3. *Introduction to Medicinal Chemistry: How drugs act and why? Gringauz, A., John Wiley and Sons, 1997.*

Paper XV (MSIC – 303) - Sugar and Pulp Chemistry

Unit I

Sugar Manufacturing

General idea about sugar factory, Introduction to carbonation and sulphitation processes and their comparison.

Carbonation process: composition of juice, extraction, clarification, sedimentation, evaporation and crystallization in brief. Sulphitation process: single and double sulphitation

Unit II

Chemical Treatment of Byproducts

i. Molasses: composition of molasses, alcoholic fermentation of molasses - manufacture of industrial alcohol, power alcohol, absolute alcohol, rectified sprit, denatured sprit.

ii. Bagasse : characteristics of bagasse, pith and fibre, production of ferfural, production of bio-gas and bio-manure, use of bagasse as fuel and cattle food, production of pulp, paper, fibre board, card board, particle board from Bagasse,.

iii. Colour: measurement of colour of sugar solution by ICUMSA (International Commission for Uniform Methods of Sugar Analysis) protocol.

Unit III

Distillery Industry

Fermentation: Types of fermentation, role of microorganisms and other conditions, production of grain spirit, production of alcohol from alternate feedstock viz. sugarbeat, cassava and lignocellulose.

Unit IV

Pulp and Paper Industry:

Pulp and paper industry in India, raw materials, classification and properties of fibrous materials, mechanical and chemical (acid, neutral and alkaline) pulping process, Lignin as a chemical raw material.

Recommended Text Books

1. *Handbook of Cane Sugar Technology* – R.B.L. Mathur
2. *Cane Sugar Manufacture in India – D.P. Kulkarni*
3. *Handbook of Cane Sugar Engineering – E. Heogot*
4. *Cane Sugar Engineering – Peter Rein*
5. *Industrial Fermentations by L.A. Under Koeffler, Chemical Pub. Co., Newyork*
6. *Pulp and Paper chemistry and Technology,* Monika E. K, Goran Gellerstedt, Gunnar Henerikssson.

Paper XVI (MSIC – 304) – Essential Oils, Dyes and Paints

Unit I

Essential Oils

Sources, Classification, chemistry of essential oil bearing materials , Methods of production of some important essential oils(rose, jasmine, khus, sandal wood etc.), Grading and Standardization , Physico-chemical characteristics.

Unit II

Dyes

Introduction, General characteristics of colour and constitution, Classification, Basic operations in dying, some commercial dyes (azo dyes, acidic dyes, basic dyes, mordant, vat dyes, indigo dyes, dispersive dyes etc.)

Unit III

Paints

General characteristic, their function, Manufacture and Classification, Enamels, Emulsion paints, Water based paints.Formulation of paints: Function of vehicles , solvent, thinner, pigment, dyes, filler, resins, drier, insecticides, additives in paint formulation

Recommended Text Books

1. *Essential Oils, Vol. I-V,* Guenther.
2. *The Essential Oil Book,* Edited by Colleen, K. Dodt.
3. *Introduction to Paint Chemistry,* G.P.A. Turner, Chapman& Hall.
4. *Basics of Paint Technology, Part I & II,* V.C. Malshe and Meenal Sikchi.
5. *Chemistry and Application of Dyes,* Editors- Waring, R. David, Geoffery.
6. *Textbook of Dye Chemistry,* Georgievice, London Scott Greenwood.
7. *Industrial Dyes: Chemistry, Properties and applications,* Edited by Klaus Hunger.

Paper XVII (MSIC – 305) - Lab Course II

1. Isolation of caffeine from tea leaves.
2. Isolation of lycopene from tomato.
3. Estimation of casein in milk.
4. Determination of density of given liquid using pycnometer.
5. To determine the surface tension of given liquid by stalagmometer.
6. Determination of free CO_2 in given water.
7. Determination of dissolution of given Caplet or tablet.
8. To determine the amount of acetic acid present in a given sample of vinegar.
9. To prepare calcium stearate from stearic acid.
10. To determine the acidity of fruit provided.
11. To study the degradation of polymers through viscosity measurement (Ostwald viscometer).
12. To determine enzyme catalysis using UV-Visible spectrophotometer.
13. Extraction and identification of DNA from green peas and onions.
14. To determine the acid value of various vegetable oils.
15. To determine the non-volatile extracts of spices.
16. Determination of salt percentage in curry powder.
17. Determination of Argemone oil in mustard oil.

Semester IV

Paper XIX (MSIC – 401) - Environmental Impact Assessment

Unit I

National Environmental Policy

The Environment Protection Act 1986. Objectives of Anti-pollution Acts.

National Policy on EIA and Regulatory Framework: Rule, regulations of central and State Government. Central and State pollution control boards for Safeguard for Environmental Protection. Rules, regulations and guidelines given for disposal of hazardous waste, municipal solid waste and bio-medical waste. Case study of current issue requirements of Rule 14 for Environmental Audit under Environmental protection Act 1986.

Unit II

Sustainable Development

Definition and concepts of sustainable development, Integration of (a) Economic, Social and Environmental sustainability (b) Biodiversity and (c) Availability of natural resources in development. Critical review of drawbacks in traditional (base on economics) evaluation of development, Cost benefit analysis. Introduction of ecological growth factor similar to economical growth factor for sustainable development.

Unit III

Methodologies for Impact Assessment

Baseline collection of data. Significant impacts, Assessment of impacts of physical, biological and socio- economic environment, Impact prediction tools / techniques such as adhoc method, checklist methods etc. Development of environment management plan – Post project monitoring, EIA report and EIS, Review process, EIA case studies / histories for industrial projects, water resources and irrigation projects, port and harbours, mining, transportation and other project sectors.

Recommended Text Books

1. *Larry W.Canter "Environmental Impact Assessment", Tata McGraw Hill Co. Singapore, 1996.*
2. *Suresh K. Dhameja, "Environment Engineering and Management", S.K. Kataria & Sons Delhi, 2004.*
3. *Relevant MoEF Notifications and CPCB / GPCB Acts & Rules, New Delhi, 2006.*
4. *Whylte, Anne, V. and Ian Burlon(eds), Environmental Risk Assessment, John Wilay and Sons, 1980.*
5. *Pares Distn. Environmental Laws in India (Deep. Deep, Lated edn.)*
6. *The ISO 14000 Handbook: Joseph Cascio.*
7. *ISO 14004 – Environmental management systems: General guidelines on principles, systems and supporting techniques (ISO 14004: 1996 (E)).*
8. *ISO 14001: Environmental management systems: Specification with guidance for use (ISO 14001: 1996b (E)). (International organization for standardization – Switzerland).*

Paper XX (MSIC – 402) - Food Technology and Agrochemicals

Unit I

Food Chemistry

Introduction, Classjfication, Properties of sugar and polysaccharides in foods, Proteins and amino acids, Vitamins and Minerals, Industrial application of enzymes, Water in food, Water activity and shelf life of food, Natural food flavours, Pigments in food and their industrial application.

Unit II

Food Microbiology

Food born infections and intoxications: bacterial with examples of infective and toxic Type Clostridiums, Salmonella, Staphylococcus. Govt. Regulatory practices and policies, FDA, ISI. Application of microbial enzymes (proteases and lipases) in dairy industry (cheese production) and beverages (beer production).

Unit III

Food Processing and Preservation

Food additives, Contaminants, Food Preservation methods, Food packaging and preservation methods of fruits, vegetables, cereals and grains.

Unit IV

Agrochemicals and their effects

Introduction, Importance and general classification of agrochemicals, mode of action, Public health issues related to agrochemicals.

Classification, Physical and Chemical Properties of Pesticides & Insecticides (BHC, DDT, Parathion & from natural sources i.e neem seed etc.), Herbicides (2, 4-dichlorophenoxyacetic acid & atrazine).

Recommended Text Books

1. *Food Microbiology ,2nd edn.*, Adams.
2. *Fundamental of Dairy Microbiology,* Prajapati.
3. *Microbiology of Fermented Foods, Vol. I & II,* Brian J. Wood, Elsevier Applied Science Publication.
4. *Principles of Food Chemistry,* John M. DeMan, Springer 1976.
5. *Introduction to food Chemistry,* Richard Owusu –Apenten, CRC Press.
6. *Chemistry and Technology of Agrochemical Formulation, Editor- A. Knowles, Springer.*

Paper XXII (MSIC – 404) - Industrial Training and Seminar Part B

Minimum 2-3 weeks training at an industry

Presentation of work done and things learnt at training

Seminar on a relevant topic of interest