PANJAB UNIVERSITY
CHANDIGARH

FACULTY OF SCIENCE

SYLLABI

FOR
INDUSTRIAL CHEMISTRY
ADD-ON COURSE
EXAMINATIONS 2021
Outlines of tests, syllabi and course of reading for “Industrial Chemistry” Add on Courses

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Industrial Chemistry and their applications. The syllabus pertaining to Industrial Chemistry Add on course in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Department of Chemistry working in the Panjab University, Chandigarh. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Subject Title: “Industrial Chemistry Add on Courses”

Certificate Course in Industrial Chemistry

| Paper A: | Core 111, 112, & 113 i.e. Industrial Aspects of Organic, Inorganic and Physical Chemistry. | 75 |
| Paper B: | Core 124, 125 and 126 i.e. Material and Energy balance; Unit operations in Chemical Industry; utilities & fluid flow and Heat transport. | 75 |
| Practicals: | Total combined practicals mentioned under Certificate Course in Industrial Chemistry | 50 |

Max. Marks

Diploma Course in Industrial Chemistry

| Paper A: | Core 231, 232 & 233 i.e. Material balance and Unit processes in Org. Chem. Manufacture I & II. | 75 |
| Paper B: | Core 244, 245 & 246 i.e. Pollution, Effluent Treatment and Waste management and Process Instrumentation. | 75 |
| Practicals: | Total combined practicals mentioned under Diploma Course in Industrial Chemistry | 50 |

Advanced Diploma in Industrial Chemistry

| Paper A: | Core 351, 352 & 353 i.e. Chemical Process Economics, Industrial Organization & Industrial Chemical Analysis. | 75 |
| Paper B: | Core 364, 365 & 366/I or II or III or IV or V or VI or VII i.e. out of Pharmaceuticals, Heavy & Fine chemicals, Petrochemicals, Waste recycling, Agrochemicals, Dyes & Polymers-any one elective is to be selected. | 75 |
| Practicals: | (i) Total combined practicals mentioned under Advanced Diploma in Industrial Chemistry. (ii) The Entrepreneurship Development course. | 50 |

Max. Marks

NOTE: The Entrepreneurship Development Course will be taught in the Industrial Chemistry programme of “Industrial Chemistry” Add on Courses for the session 2014-2015. This course being a non-credit course, the examination will be conducted by the Colleges themselves as they do for the House Examination. The result is to be conveyed in a sealed cover to the Deputy Registrar (Secrecy) P.U., Chandigarh well before the commencement of the annual Examination in April/May.
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<th>Sr. No.</th>
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JOB POTENTIAL OF VOCATIONAL PROGRAMME IN INDUSTRIAL CHEMISTRY

The graduates with Industrial Chemistry are better suited for the job requirements in an industrial environment. As the course covers almost all the aspects of a chemical industry, these students will be suitable for any Department in Chemical industry, like production Q.C., product development effluent treatment etc. They will be better motivated and chances of going up in the organization will be much higher. The suggested course for most of the part is general in nature and they could be absorbed in any Chemical Industry. The students can be employed in village industries based in agricultural raw materials or agro based industries such as insecticides. They will also be suitable for Technical Marketing of product. They can be employed by the Government in Factory Inspectorate, Pollution Control agencies and other development agencies. There is scope for them to be employed in Banks, financial institutions etc., where their experience may be utilized in Project Appraisals for purposes of financing projects. Thus, a graduate in Industrial Chemistry will be a better motivated and more useful person in the Chemical Industries and allied Government and non-Governmental bodies. It is anticipated that there will be a very good demand for these graduates.
NOTE ON SYLLABUS FOR INDUSTRIAL CHEMISTRY ADD ON COURSE

The practicals in Industrial Chemistry Add on course can be conducted in the present Chemistry undergraduate laboratories. At present, generally 40/60 students work in the laboratory and they are divided into two/three batches of 20 students each. The same strength may be maintained for the Ind. Chem. course. The normal reagents, chemicals and lab-wares provided to the Chemistry students are sufficient for Ind. Chem. students. Additional minor equipments required are given below. No costly sophisticated equipments are required for the entire course.

CERTIFICATE COURSE IN INDUSTRIAL CHEMISTRY

Paper A - No additional equipments required.

Paper B - Refractometer, Tensiometer/stalagmometer, Polarimeter, Viscometer (Ostwald).

Demonstration Experiments: Different types of valves, fittings, Laboratory models of filters, dryers, impeller

DIPLOMA COURSE IN INDUSTRIAL CHEMISTRY

Paper A - Colorimeter, pH meter, Potentiometer, conductometer, Dielectric Constant apparatus, Thermal conductivity measurement apparatus, Thermisters, thermocouples, transducers.

Paper B - Ignition point apparatus, Flash point apparatus, Rotameter, Nesseler tubes.

ADVANCED DIPLOMA IN INDUSTRIAL CHEMISTRY

Paper A - No additional equipments required.

Paper B - Special papers (Student to Opt for any one of the following).

(a) Pharmaceuticals: Micrometer, Vernier oven for drying, Microscopes, Icabat or Autoclave, glassware for microbiological testing.

(b) Heavy and Fine Chemicals: No additional equipments required.

(c) Petrochemicals: Tensiometer, Viscometers, Rotameter, Manometer, Flash point apparatus, Ignition Point apparatus, Pour point apparatus, Penetrometer, Calorimeter, Bomb Calorimeter, Oxygen cylinder.

(d) Waste recycling: Bomb Calorimeter, Cod-Incubator.

(e) Agrochemicals: No additional equipments required.

(f) Dyes: Lab dyeing bath, Light sources, colorimeter, Fluorimeter.

(g) Polymers: Viscometers, Dielectric constant apparatus, Tensile Strength apparatus.

Notes: 1. Some of the above equipments are available in the Physical Chemistry Laboratory. Hence, very few additional equipments will be needed to start the course. The equipments are not very costly.

2. As the course is a vocational course the students should make factory visits and submit the report.

3. In view of the strength of the students expected to take this course, job training may not be possible.
CERTIFICATE COURSE IN INDUSTRIAL CHEMISTRY

Paper A

Industrial Aspects of Chemistry

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Unit I

15L

Raw materials for organic compounds: Petroleum, Natural gas.
Fractionation of crude oil, cracking, reforming, hydroforming, isomerisation.
Coal: Types, structure, properties, distillation of Coal, Advantages and disadvantages of coal.

Unit II

15L

Cellulose; Viscose manufacturing and Cellulose acetate manufacturing, Manufacture of starch, dextrin and dextrose from corn, Alcohol and alcohol based chemicals oxalic acid, furfural
Basic metallurgical operations- Pulverisations, Calcinations, Roasting, Refining.

Unit III

15L

Physicochemical principles of extraction of – Iron, Lead, Silver, Sodium, Aluminum.

Inorganic materials of industrial importance-Their availability, forms, structure and modification.
Alumina, silicates and types, zeolites.

Unit IV

15L

Surface chemistry and Interfacial phenomena, Adsorption isotherm, Sols, Gels, Emulsions.
Microemulsions, Micelles, Aerosols, Effect of surfactants.

Catalysis: Introduction, Types-Homogeneous and Heterogeneous, Catalytic poisoning, Autocatalysis, Negative catalysis.
Introduction to phase transfer catalysis.
Suggested Books


Instructions for paper setters and candidates:

I. Examiner will set total of NINE questions comprising TWO questions from each unit and ONE compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.

III. All questions carry equal marks.
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UNIT I

15L

Dimensions and units: Basic Chemical Calculations-Atomic weight, molecular weight, equivalent weight, mole, mole fractions.

Material balance: The concept of material Balance, Open and closed systems, Steady state and Unsteady state systems, Multiple component systems, Accounting for Chemical Reactions in material balances, Material balance for batch and semi batch process Concept of limiting reactant conversion, yield (Qualitative treatment only).

UNIT II

15L

Energy Balance: Heat capacity of pure gases and gaseous mixtures at constant pressures. Sensible heat changes in liquids, enthalpy changes (Qualitative treatment only).

Distillation: Introduction, Batch and continuous distillation, Separation of azeotropes, Plate columns and packed columns

Absorption: Introduction, Equipments- packed columns, spray Columns, bubble columns, packed bubble columns, mechanically agitated contractors.

UNIT III

15L


Filtration-Introduction, filter media and filter aids, equipments- plate and frame filter press, nutch filter, rotary drum filter, sparkler filter, candle filter, bag filter, centrifuge.

Drying- Introduction, free moisture, equipments- tray dryer, rotary dryer, flash dryer, fluidized bed dryer, drum dryer, spray dryer.

Extraction-Introduction, selection of solvent.
UNIT IV

Fuel- Types of fuels- advantages and disadvantages of combustion of fuels, calorific value, specifications for fuel oil.

Boilers- Types of boilers and their functioning.

Water- Specifications for industrial use, various water treatments, desalination

Air- Specifications for industrial use, Processing of air.

Heat Transfer: Heat exchangers- Shell and Tube type; finned tube heat exchangers, plate heat exchangers.

Suggested Books

Instructions for paper setters and candidates:

I. Examiner will set total of NINE questions comprising TWO questions from each unit and ONE compulsory question of short answer type covering whole syllabi.
II. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.
III. All questions carry equal marks.
IV. Complex numerical problems not to be asked.
I. Simple techniques used in Chemistry lab
1. Calibration of thermometers
2. Fractional Crystallization (Copper Sulphate-Mohr Salt Solution)
3. Distillation: Simple, Vacuum, Fractional, Distillation (1 Expt. Each)
4. Filtration: Simple Filtration, Vacuum Filtration
5. Preparation of Standard solutions of NaOH, KMnO₄, H₂SO₄, HCl, Oxalic Acid, Na₂CO₃ with introduction to primary and secondary standards.
6. Determination of sulphuric acid and phosphoric acid in a mixture.
7. Determination of Elevation and depression in b.p/m.p of liquids. Determination of Vant Hoff Factor, Degree of Dissociation in strong electrolyte.

II. Applications of Refractometer, Polarimeter, Stalagamometer, Viscometer.
8. Determine the Refractive Index and polarizability of a given liquid using a refractometer.
9. Determine the concentration of sugar in a solution refractometrically.
10. Determine specific rotation of a given compound.
11. Determine the percentages of two active substances in a solution with polarimeter.
12. Identify whether the given compound is dextro-rotatory or laevo-rotatory.
13. Compare cleansing power of detergents (any two) with stalagamometer.
14. To measure the interfacial tension.
15. Determine molar mass of polymers by viscosity method.
16. Study the variation of viscosity of ethanol-water with change in composition.

III. Phase Diagram, Chromatography and Ore analysis
17. Construct a Phase Diagram: Water, Chloroform and Acetic Acid ternary system.
18. Application of Thin layer chromatography.

Instructions for paper setters and candidates:

General Instructions to the Examiners:
Note: Practical examination will be of four hours duration & shall consist of the following questions:

Q. No. I  Expt 1-7 (Perform 1 expt out of two offered)  12 marks
Q. No. II Expt 8-14 (Perform 1 expt out of two offered)  12 marks
Q. No. III Expt 15-18 (Perform 1 expt out of two offered)  12 marks
Q. No. IV  Viva-Voce  8 marks
Q. No. V  Note Book  6 marks

TRAINING/WORKSHOP/INDUSTRIAL VISITS (8 Credits)

i. Visit to a local industry during the year and students are required to submit a report on the same. The report should contain information about: Raw materials used in industry, Steps involved in manufacturing, finished product and quality control measures involved.

ii. A demonstration is to be given to students regarding use of ‘Excel’ for managing data and making graphs.

iii. Demonstration on use of software likes ISIS Draw, Chem Draw or related software available free on the internet.

iv. Each student is required to deliver a seminar/power point presentation relevant to theory/practical syllabus.
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UNIT I

Mechanical properties of materials and change with respect to temperature.

Materials of constructions used in Industry:
Metals and alloys- Important metals and alloy; Iron, Copper, Aluminium Lead, Nickel, Titanium and their alloys- Mechanical and chemical properties and their applications.
Cement- Types of cement, composition, manufacturing process, setting of cement.
Ceramics- Introduction, types, manufacturing processes, applications, Refractories.
Polymeric materials- Industrial polymer and composite materials-Their constitution, Chemical and physical properties, Industrial applications.
Glass-Types, composition, Manufacture, Physical and Chemical properties, Applications.
Corrosion- Various types of corrosion relevant to chemical industry-Mechanism, Preventive methods.

UNIT II

Nitrification: Introduction-Nitrating agents, Kinetics and mechanism of nitration processes such as nitration of:
Paraffinic hydrocarbons, Benzene to nitrobenzene and m-dinitrobenzene, Chlorobenzene to o-and p-nitrochlorobenzenes, Acetanilide to p-nitroacetanilide, Toluene
Continuous vs batch nitration.
Halogenation: Introduction-Kinetics of halogenation reactions,
Reagents for halogenation, Halogenation of aromatics-side chain and nuclear halogenations.
Commercial manufactures-chlorobenzenes, chloral monochloracetic and chloromethanes, dichlorofluoromethane.

UNIT III

Sulphonation: Introduction-sulphonating agents,
Chemical and physical factors in sulphonation.
Kinetics and mechanism of sulphanation reaction,
Commercial sulphonation of benzene, naphthalene, alkyl benzene, Batch vs continuous sulphonation.
**Oxidation:** Introduction-Types of oxidation reactions, oxidizing agents, Kinetics and mechanism of oxidation of organic compounds Liquid phase oxidation, Vapor phase oxidation Commercial manufacture of benzoic acid maleic anhydride, phthalic anhydride, acrolein, acetaldehyde, acetic acid.

**Esterification:** commercial manufacture of- ethyl acetate, dioctyl phthalate, vinyl acetate, cellulose acetate

**Hydrolysis:** Introduction, hydrolyzing agents, Kinetics thermodynamics and mechanism of hydrolysis

**UNIT IV**

**Hydrogenation:** Introduction-Kinetics and thermodynamics of hydrogenation reactions, Catalysts for hydrogenation reactions, Hydrogenation of vegetable oil, Manufacture of methanol from carbon monoxide and hydrogen, hydrogenation of acids and esters to alcohols, catalytic reforming.

**Alkylation:** Introduction,Types of alkylation, Alkylating agents. Thermodynamics and mechanism of alkylation reactions, Manufacture of-alkylbenzenes (for detergent manufacture), ethylbenzene, phenyl ethyl alcohol, N-alkyl anilines (mono and di-methyl and ethyl anilines).

**Amination:** By reduction: Introduction Methods of reduction-metal and acid, catalytic, sulfide, electrolytic, metal and alkali sulfites, metal hydrides, sodium metal, concentrated caustic oxidation, reduction, commercial manufacture of aniline, m-nitroaniline, p-amino phenol.

**Suggested Books**


**Instructions for paper setters and candidates:**

I. Examiner will set total of \textbf{NINE} questions comprising \textbf{TWO} questions from each unit and \textbf{ONE} compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt \textbf{FIVE} questions in all, \textbf{ONE} question from each unit and the Compulsory question.

III. All questions carry equal marks.
PRACTICALS

**Unit process:** One to two examples of each of the following unit processes
Nitration, sulphonation, Friedel-crafts reactions, esterification, Hydrolysis,
Oxidation, Halogenation, chlorosulphonation, Reduction, polymerization, reactions of diazonium
salts.

**Instrumental methods of analysis:** Use of colourimeter, pH meter, potentiometer,
conductometer, refractometer, polarimeter.

**Material testing:** Testing of alloys Identification of plastics/rubber Estimation of yield point
Young’s modulus, flaredness, Optical thermal mechanical and electrical properties.

Process Instrumentation-transducers of different types.
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UNIT I

Air, Oxygen, nitrogen cycle, water
Biosphere flora and fauna energy soil
Pollutants and their statutory limits.
Pollution evaluation methods.

Air pollution-Various pollutants.
Water pollution-Organic/inorganic pollutants.
Noise pollution, Sewage analysis, Pesticide pollution
Radiation pollution, Green house effect, Future.

UNIT II

Principles and equipments for aerobic, anaerobic
Treatment, adsorption, filtration, sedimentation.
Bag filters, electrostatic precipitator, mist eliminators, wet scrubbers, Absorbers

UNIT III

Solid waste management, Industrial safety
Concept of measurement and accuracy
Principle, construction and working of the following measuring instruments:
Colorimeter, Nephelometer, Flame Photometer,
Differential Scanning Calorimeter (DSC), Thermogravimetric Analysis (TGA).

UNIT IV

Temperature- glass thermometers bimetallic
Thermometer pressure spring thermometer, vapor filled thermometer, resistance thermometers.

Pressure- Manometers, barometers bourdon
Pressure gauge bellow type, diaphragm type pressure gauges macleod gauges, Pirani gauges etc.
Liquid level: Direct- indirect liquid level
Measurement float type liquid level gauge, ultrasonic level gauges, bubbler system
Density measurement, Viscosity measurement
Suggested Books


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II. The students are required to attempt \textbf{FIVE} questions in all, \textbf{ONE} question from each unit and the Compulsory question.

III. All questions carry equal marks.
PRACTICALS

I. Unit Process
   Nitration of benzene/acetanilide
   Sulphonation: To prepare sulphanilic acid from aniline
   Friedel Craft’s reactions: To prepare acetophenone/toluene from benzene
   Esterification: Conversion of acetic acid into ethyl acetate
   Hydrolysis: To prepare p-nitroaniline from p-nitroacetanilide
   Polymerization: Preparation of Nylon 6.6 etc. (any One)

II. Instrumental methods of analysis

Use of colorimeter:
1. Verify Beer’s Law for KMnO$_4$ and K$_2$Cr$_2$O$_7$ solution and measure concentration of
given solution of unknown concentration.
2. Determine iron in a sample of water colorimetrically.

pH meter:
1. Find the normality and strength of a given NaOH solution by titrating against Standard
   HCl using a pH Meter.
2. Titrate Phosphoric acid and NaOH using pHmetry

Potentiometer:
1. Titrate HCl and NaOH Potentiometrically
2. Determine dissociation constant of acetic acid using potentiometer

Conductometer:
1. To verify Debye-huckel onsager equation.
2. Study the variation of conductance with dilution in case of strong and week electrolytes.
3. Verify Kohlrauch Law e.g. Find Molar Conductance of Acetic acid at infinite dilution
   Polarimeter

Flash Point Apparatus:
1. Determine the flash point and fire point of oils.

Material testing
1. Testing of alloys: Any one out of brass/bronze/nickel coin/silver coin/solder
2. Identification of plastics/rubber Estimation of yield point young’s modulus.
3. Optical thermal mechanical and electrical properties
4. Use of Transducers for measuring flow control.
5. Water analysis-solid content, Hardness, COD and other tests as per industrial
   specifications.
7. Monographs of representative raw materials such as sulphuric acid. Sodium
   carbonate, sodium hydroxide,
8. Limit tests for heavy metals Pb, As, Hg, Fe and ash content.
Instructions for paper-setters and candidates:

General Instructions to the Examiners:

Note: Practical examination will be of four hours duration & shall consist of the following questions.

Q.No. I. Unit Process (Perform 1 expt out of two offered) 12 marks
Q.No. II. Instrumental methods of analysis (Perform 1 expt out of two offered) 12 marks
Q.No. III Material testing (Perform 1 expt out of two offered) 12 marks
Q.No. IV Viva-voce 8 marks
Q.No. V Note book 6 marks

TRAINING /WORKSHOP/ INDUSTRIAL VISITS (8 CREDITS)

i. Visit to a local industry during the year and students to submit a report on the same. The report should contain information about: Raw materials used in industry, Steps involved in manufacturing, finished product and quality control measures involved.
   (Different from the one submitted in 1st Year)

ii. A demonstration be given to students regarding use of excel for managing data and making graphs.

iii. Submission of worksheets based on Internet Software like ISIS Draw, Chem Draw and use of 3D Software like MDL Chime, Cosmo Player etc.

iv. Students will also submit a project report on water-effluent analysis/soil analysis/food adulteration etc. (Different from the one submitted in first year)

v. Student to submit a report on one small scale unit: Safety matches, Naphalene balls, Wax candles, Shoe Polish, Gum Paste, Pen Ink, Chalk, Plaster of paris.

vi. Each student to present a seminar relevant to the syllabus.
Chemical Process Economics

**OBJECTIVE OF THE COURSE**

To teach the fundamental concepts of Industrial Chemistry and their applications. The syllabus pertaining to Industrial Chemistry Add On courses in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Department of Chemistry working in the Panjab University, Chandigarh. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**Unit-I**

15L

Factors involved in project cost estimation,
Methods employed for the estimation of capital investment.

Capital formation, Elements of cost accounting
Interest and investment costs, Time value of
Money-equivalence.

Depreciation methods of determining
Depreciation Taxes.

Some aspects of marketing, pricing policy.
Profitability criteria, Economics of selecting
Alternatives.

Variation of cost with capacity break-even
Point. Optimum batch sizes, production, scheduling etc.

**Suggested Book**

Economics of Chemical Industry, Hempel. E.H

**Unit-II**

15L

Concept of scientific management in Industry
Functions of management decision making
Planning organizing directing and control.
Location of industry
Materials management
Inventory control
Management of human resources-selection
Incentives, welfare and safety.
Suggested Books
2. Industrial Organization and Management, Bethel L.L.
3. Industrial Engineering and Management Science, Banga T.R., Agarwal N.K
4. Business Organisation and Management, Bhushan Y.K.

Unit-III
15L
Industrial Analysis:
Sampling procedures, sampling of bulks materials
Techniques of sampling solids, liquids and gases
Collecting and processing of data
Chromatography paper chromatography TLC, GLC, HPLC
Particle size determination
Rheological properties of liquids plastics and their analysis

Suggested Books

Unit-IV
15L
Modern instrumental methods of analysis:
UV-visible spectroscopy
IR-spectroscopy and non-dispersive IR
NMR-spectroscopy
Atomic Absorption Flame photometry
Neutron diffraction
X-ray fluorescence
Ion-selective electrodes
Ion-chromatography

Suggested Books
Instructions for paper setters and candidates:

I. Examiner will set total of **NINE** questions comprising **TWO** questions from each unit and **ONE** compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.

III. All questions carry equal marks.

**PRACTICALS**

1. Industrial Analysis-Analysis of common raw materials as per the industrial specifications, such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, epoxide, oils, etc.

2. Synthesis of common industrial compounds involving two step reactions for example: 4-Bromoaniline, 3-nitroaniline, sulphanilamide 4-Aminobenzoic acid, 4-Nitrobenzoic acid, Dihalobenzenes, Nitrohalobenzenes
OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Industrial Chemistry and their applications. The syllabus pertaining to Industrial Chemistry Add on courses in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Department of Chemistry working in the Panjab University, Chandigarh. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Unit-I

Historical background and development of Pharmaceutical Industry in India in brief.

Pharmacopoeias-Development of India Pharmacopoeia and Introduction to B.P., U.S.P., E.P., N.F. and other important pharmacopoeias.

Introduction to various types formulations and roots of Administration.

Aseptic conditions need for sterilization, various methods of sterilization.

Various types of pharmaceutical excipients-their Chemistry, process of manufacture and quality specifications- Glidants, lubricants, diluents, preservatives, antioxidants, emulsifying agents, coating agents, binders, colouring agents, flavouring agents, gelatin and other additives, sorbitol, mannitol, viscosity builders, etc.

Suggested Books
Indian Pharmacopoeia Commission, Indian Pharmacopoeia 2007, 3 Vols. with One Supplement (Addendum 2008).
The British Pharmacopoeia 2010

Unit-II

Surgical dressings sutures ligatures-with respect to the process equipments used for manufacture method of sterilization and quality control.

Pharmaceutical packaging-Introduction package, Selection of packaging materials ancillary materials packaging machinery quality control of packaging materials. FDA, Important schedules and some legal aspects of drugs

Phytochemicals-Introduction to plant classification and Crude drugs cultivation collection preparation for the market and storage of medicinal plants.

Evaluation of crude drugs-Moisture content Extractive Value, volatile oil content, foreign organic matter.
Quantitative microscopic excercises including of starch leaf content (Palisade ratio stomatal number and index vein islet number and vein termination number) crude fibre content.
Introduction to chromatographic method of identification of crude drugs.

**Suggested Books**

Indian Pharmacopoeia Commission, Indian Pharmacopoeia 2007, 3 Vols. with One Supplement (Addendum 2008).
The British Pharmacopoeia 2010

**Unit-III**

15L

Chemical constitution of plants-including carbohydrates, amino acids, proteins fats waxes, volatile oils, terpenoids, steriods, saponins, flavonoids, tannins, glycosides, alkaloids.

Various isolation procedures for active ingradients with example for alkaloid e.g., vincaalkaloids, reserpine one for steroids sapogenin osigen, diagroh.

Pharmaceutical quality control (other than the Analytical methods covered under core subject) Sterility testing, Pyrogenic testing glass testing bulk density of powder etc.

Classification of various types of drugs with examples.

Raw materials, process of manufacture effluent handling etc., of the following bulk drugs

1. Sulpha drugs-Sulphaguandine, sulphamethoxazele
2. Antimicrobial-chloramphenicol furazolidine mercurochrome isoniazid Na-PAS.

**Suggested Books**

5. Indian Pharmacopoeia Commission, Indian Pharmacopoeia 2007, 3 Vols. with One Supplement (Addendum 2008).

**Unit-IV**

15L

Classification of various types of drugs with examples.

Raw materials, process of manufacture effluent handling etc., of the following bulk drugs

Steroidal hormones-Progesterone, Testosterone, methyl testosterone.

Vitamins-Vit. A, Vit. B6, Vit. C

Barbiturates-Pentobarbital

Blickers-Propranolol, atenolol

Cardiovascular agent-Methyl depa

Antihistamines-Chlorophener amine maleate.
Products based on fermentation processes
Brief idea of microorganisms, their structure, growth and usefulness.
Enzyme systems useful for transformation microbial products.
General principle of fermentation processes and product processing.

Manufacture of antibiotics-Penicillin-G and semisynthetic penicillins,
Rifamycin, tetracyclins, Vit, B12. Biotransformation processes-for prednisolone, 11-
hydroxylation in steroids.
Enzyme catalyzed transformation manufacture of ephedrine.

Suggested Books
Williams & Wilkins, 2007.
Wiley Interscience, 2008.
5. Indian Pharmacopoeia Commission, Indian Pharmacopoeia 2007, 3 Vols. with One
Supplement (Addendum 2008).

Instructions for paper setters and candidates:

I. Examiner will set total of NINE questions comprising TWO questions from
each unit and ONE compulsory question of short answer type covering whole
syllabi.

II. The students are required to attempt FIVE questions in all, ONE question
from each unit and the Compulsory question.

III. All questions carry equal marks.
PRACTICALS

Demonstration of various pharmaceutical packaging expt. Materials, Quality control tests of some materials Aluminium strips, cartons, glass bottles (Demonstration only). Limit tests for chlorine, heavy metals, arsenic Etc. of two representative bulk drug.
Demonstration of various pharmaceutical products.
Active ingredient analysis of few types of formulations Representing different methods of analysis Acidimetry, Alkalimetry, nonaqueous complexometry, potentiometry etc.
Determination of sulphate ash, loss on drying and other tests of bulk drugs, complete I.P. monograph of three drugs representing variety of testing methods.
Determination and identification of starch granules, calcium oxalate. stomatal index determination. Identification of few drugs. TLC method for identification

Instructions for paper-setters and candidates:

General Instructions to the Examiners:
Note: Practical examination will be of four hours duration & shall consist of the following questions.

Q.No. I. Determination of acetone, phenol, aniline content in given formulation etc. / Experiments based on Monogram/Acidimetery/Alkalimetry etc. (Perform one experiment out of two offered) 12 marks
Q.No. II. Experiment on retention factor of a given drug by TLC method/limit Tests Chlorine heavy metals etc. Or Experiments on Venturimeter/ Tablet disintegration apparatus etc. 12 marks
Q.No. III Organic Synthesis involving two steps 12 marks
Q.No. IV Viva-voce 8 marks
Q.No.V Note book 6 marks

TRAINING /WORKSHOP/ INDUSTRIAL VISITS (8 CREDITS)

i. Visit to a pharmacy industry during the year and students to submit a report on the same. The report should contain information about: Raw materials used in industry, Steps involved in manufacturing, finished product and quality control measures involved.
ii. Students to attend workshops on open source software related to chemistry like GChem Paint etc.
iii. Each student to present a seminar relevant to the syllabus.
iv. Students will also submit a project report on water-effluent analysis/air analysis/soil analysis/food adulteration etc. (Different from the one submitted in second year)
HEAVY AND FINE CHEMICALS

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Industrial Chemistry and their applications. The syllabus pertaining to Industrial Chemistry Add on courses in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Department of Chemistry working in the Panjab University, Chandigarh. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Unit-I
Manufacture of the following with reference to (i) consumption Pattern (ii) Raw materials (iii) Production process (iv) Major engineering aspects (v) Special material of constructions (vi) Quality control (vii) Hazards ana safety (viii) Effluent management. 6L

Synthetic nitrogen products-Ammonia, nitric acid ammonium nitrate and ammonium sulphate. 3L

Chlor- alkali industrial products- Caustic soda Chlorine. Phosphorus chemicals-Phosphorus, phosphoric acid ammonium phoaphate, superphosphate, triple superphosphate. Industrial carbon-carbon blacks, manufactuer of graphice and carbon. 3L

Lime, gypsum,
Silicon, calcium carbide, silicon carbide
Flourine, Bromine, Iodine, hydrobromic acid, Interhalogen compounds. 3L

Unit-II
Sodium chloride, sodium sulphate, sodium sulphite, sodium thinosulphate, borax boric acid. Industrial catalysts-Raney nickel other forms of nickel palladium and supported palladium copper chromate, vanadium and platinum based catalyst. 6L

Aluminium alkoxides, titanium tetrachloride, and titanates, titanium dioxide. Manufacture of the following with reference to (i) Raw materials (ii) Flow chart (iii) Effluent management (iv) Kinetics (v) Uses 3L

Fischer-Tropsch Synthesis-Examples

Applications and uses of zeolites as catalyst. Their use in isomerization and dehydration/dehydroxyllation. 3L

Chemicals derived from acetylenes-Acetylene, propyl alcohol 1,4-butene diol, acrylates, vinyl esters, vinyl chloride. Pyridine, picolines, phenol, acetone, resorcinol, phthalic, anhydride. 3L
Unit-III
Glycerol, sorbitol, melamine, formaldehyde, formic acid,

Triphenyl phosphine, alkyl phosphates chlorination of methane-to methyl chloride, dichloromethane chloroform carbon tetrachloride.
Ethanolamine, mono-di-tri ethanolamines, Dialkyl aminoethanols (dimethyl, diethyl).
Alkylamines-Methylamine, ethylamine, di-tri alkylamines (methyl, ethyl) butyl amines, propyl amines. 5L

Ketene, ethyl and methyl acetoacetates.
Acetaldehyde, paraldehyde
Speciality industrial solvents-DMF, DMSO, sulpholane alkylpyrrolidone, THF, dibutyl ether, diethyl ether, diglyme dimethoxy ethane dioxane. 4L

Reagents- Laboratory chemicals from heavy chemical
Industry in required purity-Acids, alkalis, carbonates, drying agents. Analytical reagents-Sodium carbonate,sodium bicarbonate, potassium dichromate, oxalic acidperchloric acid, Common solutions-Fehling solution, karlfisher reagent. 3L

Chromatographic materials and HPLC solvents- Coating material, precoating of plates, Spectroscopy grade chemicals methanol, ethanol, potassium bromide, carbon tetrachloride nujol, chloroform. 3L

Unit-IV
Biochemical reagents-Ninhydrin, tetrazolium blue, 1,2-Naphthaquinone-4-sulphonate. 2L Manufacture of following fine chemicals with reference to
(i)Raw material of common industrial compound involving two step reactions-for example 4-Bromoaniline, 3-Itroanilinesulphural
(ii) Production process
(iii) Special material of construction (iv) Hazard and safety
(v) Effluent management
(vi) Quality control (vii) Specifications.
Sodium borohydrate, lithium aluminium hydride sodium Amide, sodium ethoxide, sodium methoxide
Paracetamol, 5L

Indigo vat dyes, reactive dyes
Essential oils-general, organic flavour, camphor, citral, citronellor, menthol Surfactants and emulsifying agents-PEG, Tweens, Spans. 3L

Colouring agents-Manufacture of some natural colours and synthetic colours flavouring agents-Fragrances and Food additives.
Natural tartaric acid (i) tartaric acid Resolution of Tartaric acid
Citric acid 5L Chemicals required for electronic industry
Suggested Books


Instructions for paper setters and candidates:

I. Examiner will set total of NINE questions comprising TWO questions from each unit and ONE compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.

III. All questions carry equal marks.

**PRACTICALS**

Preparation of Raney-Nickel from Ni-Al alloys and testing its properties. 1 L
Any one reaction using the above catalyst. 1 L
Preparation of synthetic zeolites. 2 L
Preparation using zeolites. 2 L
Preparation of aluminium isopropoxide and reactions using the same. 4 L
Synthesis of trimethyl phosphate and related reagents and applications of this for o-alkylation and N-alkylation. 4 L
Preparation of reagent grade chemicals-Sodium carbonate, sulphuric acid etc., solvents etc. Synthesis of few fine chemicals -for example, Amyl acetate, floavour chemicals Paracetamol, sulphanilamide. 6 L
Purification of lemon grass oil to obtain citral. 6 L
Resolution of farteric acid and-phehyl ethyl amine. 6 L
Isolation of some natural products, like tartaric acid citric acid, etc. 4 L
PETROCHEMICALS

OBJECTIVE OF THE COURSE

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Unit-I

Introduction to crude oil, exploratory methods, oil reservoirs, transportation of crude oil, Constitution of crude oil, Natural gas-constituents
Distillation of crude oil, Separation of natural gas and different fractions based on relative volatilities, Compositions of different distillates
Meaning of terms such as-Pour point depressants, drag reducers, viscosity reducers ignition point, flash point, octane number, doctor solution.
Types of hydrocarbon fuels and their characteristics
Detailed discussion of the following operations with respect to process, mechanism, catalysts used and applications, Cracking-Catalytic cracking

Unit-II

Hydrocracking, Isomerization, Reforming, Isomerization, Alkylation.
Sulphur, hydrogen, petroleum coke and nitrogen Compounds from petroleum.
General discussion of the following reactions with respect to mechanism and applications-Oxidation ammonidation, hydro-formylation, hydration.

Unit-III

Manufacture of the following compounds. Methane ethylene, acetylene, propylene, C-4, Hydrocarbons, higher olefins.
Preparation of reagent grade chemicals-Sodium Carbonate black, hydrogen cyanide, chlorinated Methanes, carbon disulphide.
Preparation of the following from ethylene-Ethyl chloride, ethanol, ethylene oxide, ethylene glycol, acetaldehyde, acetic acid, styrene, vinyl acetate, ethanolamines, vinyl chloride, acrylonitrile.
Unit-IV
Manufacture of the following from propylene
Isopropanol, cumene, glycerine, acrylonitrile. 2L

Manufacture of the following from acetylene
Vinyl chloride chloroprene, acrylonitrile, acetaldehyde. 2L

Manufacture of the following from C-4 hydrocarbons
Butadiene, isobutene, isobutene, butanediols, oligomers 2L

Manufacture of aromatic compounds-Benzene,
toluene, xylene, naphthalene, linear alkyl benzenes
and their sulphonates, detergents. 3L

Various catalysts used in petrochemical industry,
Preparation, structure, applications and selectivity. 2L

Importance of petroleum and petroleum industry in
the context of Indian economy.

Indian petrochemical industry-Indian reserves,
Quality and petroleum distribution, Future. 4L

Suggested Books

Instructions for paper setters and candidates:
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III. All questions carry equal marks.
PRACTICALS

Viscosity-Viscosity of hydrocarbons and hydrocarbon mixture, Effect of Viscosity reducers.
Surface tension-Surface tension of different liquids, effect of surfactants.
Flow measurement in pipes of different materials effect of drag reducers.
Measurement of flash point, ignition point, pour point of pour point departments.
Determination of calorific value
Preparation of a few catalysts used in petrochemicals industry like doped silica gel aluminas treatment of silica gel and alumina with acids. Characterization of coke.

Characterization of bitumen.
Characterization of petrol kerosene, diesel, furnace oil, with respect to flash point viscosity, surface tension compositions distillation fractions. Hydration of olefins-styrene.
Dehydration of alcohols-tert-butanol.
Sulphonation of aromatics and preparation of the sodium salt of the sulphonic acid as a detergent.
OBJECTIVE OF THE COURSE

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Unit-I

**Need for waste recycle:** Limitations of raw material resources, waste elimination
Conversion of waste into useful products
Identification and quantification of industrial domestic and agro waste.

Feasibility of recycle, Separation of wastes-solid, Liquid, gaseous. 3L

**Solid wastes:** Removal of solid contaminants from water
by coagulation, sedimentation, flocculation, solid waste disposal, incineration, fuel palletization, soil conditioning. 5L

**Water management:** Waste water treatment. Biological, physical and chemical treatment. 7L

Unit-II

Treatment of water and its reuse in industries, agriculture, oil refineries, thermal power station and domestic uses. Reuse of cooling water. 7L

**Physical and chemical processes used for the recovery of Important compounds from waste**
Activated carbon adsorption, ion exchange process, evaporation, extraction, distillation, centrifugation, filtration, coagulation, membrane processes-osmosis-reverse, osmosis, electrodialysis, advanced oxidation processes 8L

Unit III

Pervaporation, freezing processes.

**Biological processes for the treatment of waste water:**
Trickle filters, activated sludge process, microbial degradations. 4L

**Gaseous wastes:**
Adsorption, catalytic/non-catalytic conversion recovery of important gases, CO₂, SO₂, NOₓ, etc., electrostatic precipitation, bag filters, wet/dry grid arrestors. 6L

Characterization of wastes, their management and recovery of important compounds from the wastes from the following industries: Dyestuff, Fertilizers, Textile 5L
Unit-IV
Water treatment of following industries:
Oil, fats and soap iron and steel plants 5L
Tanneries, slaughter houses, rubber, sugar, heavy chemicals, fermentation 5L
Thermal power stations, electroplating, paper, paint.
Economics of recycling of waste 5L

Suggested Books

Instructions for paper setters and candidates:
I. Examiner will set total of NINE questions comprising TWO questions from each unit and ONE compulsory question of short answer type covering whole syllabi.
II. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.
III. All questions carry equal marks.

PRACTICALS
Estimations of SO₂, NH₃, NOₓ
Estimation of hardness, acidity, alkalinity and pH of water.
Estimation of BOC, COD content of effluent water from different industries.
Analysis of the solid contents from the liquid effluent from different industries, separation of the constituents, chromatographic separation-TLC, paper chromatography.
**Ion exchangers:** Ion exchange capacity of resins, softening of hard water, separation of important metals, Fe, Ni, Cr from the effluents and their estimations.
**Activated carbon:** Efficiency of carbon, adsorption isotherms, separation of some important chemicals by adsorption on carbon.
Fuel pallets from garbage and solid wastes. Calorific value.
The students are expected to collect solid and liquid wastes from nearby industries and analyse with respect to constituents recovery of important constituents and disposal methods.
OBJECTIVE OF THE COURSE
To teach the fundamental concepts of Industrial Chemistry and their applications. The syllabus pertaining to Industrial Chemistry Add on courses in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Department of Chemistry working in the Panjab University, Chandigarh. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Unit-I

Pests and pest control, Types of pests, Types of Chemicals used to control pests. 3L

**Types of pesticides**- Stomach poison, contact poisons systemic poisons, fumigants.

**Insecticides:**

- **Inorganic insecticides**- Arsenic insecticides, Paris green, fluoro insecticides. 4L
- **Insecticides of plant origin**–Nicotine, nornicotine, Pyrethroids, rotenoids, anabasin, allethrin. 3 L

**Chlorinated hydrocarbons**- DDT, DDD, nestran dilan, Perthane, dikite, chlorobenzilate, suphenex. Ovotran, aramite, DFDT. SAR in the class and mode of action. 3L

Unit-II

BHC, chlordane, heptachlor, aldrin, doeldrin, endrin feodrin endosulfan, SAR in the class and mode of action. 4L

**Organophosphorus insecticides:** Introduction, Phosphoric acid derivatives- Dimecron, Dichlorovos, naled phosphinon, etc. SAR in the class. 6L

Dithiophosphonic acid-derivatives-Melathion

Dimethoate, thiocron, formothion, mecarbam etc. 5L

Thiophosphoric acid-Parathion, methyl parathion,
Unit-III

Thiophos, demeton, chlorthion, paraoxon, etc.
Phyrophosphoric acid derivatives-TEPP, sulfotepp, schradan

other organophosphorus, insecticides-Isopestox, trichlorofon, IPN.

Carbamate insecticides- Carbaryl, isolan, mesurol, zectran, demetran, pyrolan, baygon, mode of action.

Fungicides-General introduction

Inorganic fungicides- Sulphur, Lime sulphur, copper sulphate, Bordeaux mixture, Bordeaux paste, Bordeaux paint, Burgundy mixture, copper oxychloride, cuprous oxide, mercurous chloride.

Organomercuric compounds- ethyl mercuric chloride, Ceresin-M, panogen, agalol, uspulan, puratized, germisan, Mode of action, agresan GN

Unit-IV

Dithiocarbamates- Ziram, ferbam, thiram, nabam, Zineb, mane, captan, hinesanm vapam, etc., mode of action.

Miscellaneous fungicides- Dithanon, dichlons, captan, polpet, difolatan, mesulfan, brestan, dodine, glyodin, methyrimol, terrazele.

Herbicides- Introduction 2,4,D, 2, 4-DB, 2, 4-DES, MCPB, 2, 4, 5-T. Monujron, Fenuron, TCA, paraquat.

Fumigants- HCN, CS, ethylene, balides, durofume, methyl halides.

Rodenticides- Zice phosphides, warfarin,
Nematicides- DD mixture, aldiearb, fensulfothion.

Plant growth regulators- Introduction, gibberilic acids, indole acetic and butyric acids Naphthalene acetic acid, cycocl. Mode of action.

Formulation of pesticides-Dry formulation Dusts, granules, wettable powders, seed disinfectants liquid formulations Emulsions, suspensions, etc.

Suggested Books
Instructions for paper setters and candidates:

I. Examiner will set total of **NINE** questions comprising **TWO** questions from each unit and **ONE** compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.

III. All questions carry equal marks.

**PRACTICALS**

Isolation of nicotine from tobacco leaves/waste.
Preparation of copper sulphate, Estimation of copper in sulphate formulation, Formulations of copper sulphate.
Estimation of arsenic in arsenic insectioides.
Isolation and estimation of active ingredients of commercially available insecticide formulations.
Preparation of selected pesticide formulation in the form of dusts, emulsions, sprays.
Estimation of pesticide residues in food articles.
Study of the degradation of pesticides in soil in the presence of sunlight and moisture.
Determination of pesticide contents in the soil.
Effect of plant growth regulators on the development of plants and fruits.
Industrial visits to agrochemicals industry and submission of reports.
PAPER B

DYES

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Industrial Chemistry and their applications. The syllabus pertaining to Industrial Chemistry Add on courses in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Department of Chemistry working in the Panjab University, Chandigarh. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Unit-I

Chemistry of Intermediates

Introduction of the History of Dyes. Natural to synthetic dyes, landmarks in the historical development. 5L

Benzene intermediates- Chloronitrobenzenes, Nitroanilines, Bromonitroanilines, Nitroanisoles, Toluene and xylene intermediates, xylidines, Diaminobenzenes, etc. 5L

Naphthalene intermediates- H- and J-acid, R-acid, acid, N-W-acid, Chicago acid, Schaffer R and G acid, Naphthols, Naphthol sulphonic acids, Naphthylamine sulphonic acids. 5L

Unit-II

Anthraquinone intermediates and miscellaneous intermediates

1-Amino and 2-amino anthraquinones, Bromamine acid, Quinazirin, methyl and methylamino anthraquinones, Disperse dye intermediates, Disperse-reactive intermediates, Acid-dye intermediates. 5L

Introduction classification of dyes on the basis of structure and the mode of application to the fibre. Colour and chemical constitution of dyes. 2L

Chemistry of the following dyes with respect to general structural features, chemistry, mode of application to fibre, colour shades, synthesis of typical 4-5 dyes., uses. 5L

Azodyes-Acid, acid mordant, direct, milling, and stilbene azo dyes 3L
Suggested Book

Unit-III

Basic dyes
Anthraquinone (vat) dyes
Indigoid dyes
Reactive dyes
Disperse dyes
Optical whiteness—Cyanuric chloride based optical whiteners.

Analysis of intermediates—Different methods used in the analysis.
Nitrite value determination, coupling value, titanous chloride reduction, chromatography, halogen content determination, set point, iodimetry, metal estimations—Cu, Ni, Cr, etc.

Suggested Book

Unit-IV

Dyeing—General introduction to dyeing methods. Dyeing methods for the following dyes—Direct, acid, reactive, disperse, vat, cationic, sulphur, indigo, azoics.

Quality control and factory layout for dyestuff industry
Effluent treatment and pollution control in dye stuff industry.

Suggested Book

Instructions for paper setters and candidates:

I. Examiner will set total of NINE questions comprising TWO questions from each unit and ONE compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.

III. All questions carry equal marks.

PRACTICALS

1. Analysis of intermediates—Nitrite titrations, diazocoupling, titanous chloride titration, estimations of Cu, Ni, Cr, etc. TLC of intermediates, paper chromatography of dyes.

2. Dyeing – Dyeing of the following dyes on cotton-direct, Azoics, Acid-on wool and silk, TPM-on silk, Vat, Reactive, Sulphur. Evaluation of the fastness properties of dyes with respect to light, washing and sublimation.

3. Preparation of Methyl orange, Methyl red, orange II, Fluorescein, Anthraquinone.
OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Industrial Chemistry and their applications. The syllabus pertaining to Industrial Chemistry Add on courses in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Department of Chemistry working in the Panjab University, Chandigarh. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Unit-I

Brief history of macromolecular science. General characteristics of polymers in comparison with common organic compounds.
Nomenclature. Distinction between plastics, elastomers and fibres. 4L

Natural polymers—Cellulose, silk, gums, rosin and shellac

Types of polymers—Thermoplastics and thermosettings.
Functionality concept
Concept of crosslinking—Linear, m branched and crosslinked polymers. 5L

Types of polymerization—Addition, condensation, ionic, coordination.
Addition-polymerisation—Mechanism, initiation, propagation and termination processes, initiator, inhibitors.
Mechanism of ionic polymerisation. 6L

Unit-II

Methods of polymerization—Bulk, suspension emulsion, solution.
Necessity of copolymers and copolymerisation, Blocks and graft copolymers
Detailed study of the following thermosetting polymers with respect to synthesis, chemistry, properties and applications.
(i) Phenol-formaldehyde resins
(ii) Amino-resins—Urea-formaldehyde and melamine formaldehyde resins
(iii) Polyurethanes
Mechanism of ionic polymerisation. 5L

Detail study of the following thermoplastic polymers with respect to synthesis, chemistry, properties and applications.
Polyolefine—Polyethylenes—HDP, LDP, LLDP, Polypropylene,
Ethylene-propylene copolymers. 6L

Polyvinyl chloride—Grades of PVC, Teflone
Polystyrene—Homopolymers, copolymers such as SER, ABS, SAN. 4L
### Unit-III

**Vinyl polymers** - Polyvinyl acetate and its modifications like PVA, PVB and polyacetals.  
**Vinyl polymers** - Nylon-6, Nylon-66 and other Nylons.

**Polyethers and polyesters** - Terephthalates.  
**Cellulosics** such as esters, ethers, acetates, butyrate, nitrate, CMC, Regenerated celluloses.

**Molecular weight and molecular weight distribution** - Number, weight and viscosity average molecular weights of polymers, Methods of determining molecular weight, Practical significance of molecular weight distribution. Size of polymers.

### Unit-IV

Introductory concepts of kinetics of polymerization and Carother’s relation.  
Glassy state, glass transition temperature, TGA, Factors affecting GTT, Crystallinity in polymers.

Viscosity, solubility, optical properties, electrical properties, thermal properties, mechanical properties of polymers.

Degradation of polymers by thermal, oxidative, mechanical and chemical methods.

Polymer processing - Compression moulding, casting, extrusion. Fibre spinning, injection moulding, thermoforming, vulcanization of elastomers, Polymer industry in India.

### Suggested Books

Instructions for paper setters and candidates:

I. Examiner will set total of **NINE** questions comprising **TWO** questions from each unit and **ONE** compulsory question of short answer type covering whole syllabi.

II. The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.

III. All questions carry equal marks.

**PRACTICALS**

1. Determination of –(i) Acid value- Rosin ester gum, plasticizers, polyester resin, alkyd resin (ii) Iodine number-Linseed oil, castor oil (iii) Saponification value-Coconut oil, polyester (iv) Melting point and softening point- Epoxy resin, ester gum, nylon-6 (v) Viscosity- Nitrocellulose-polystyrene, PV acetate (vi) Hydroxyl value.


3. Identification of simple polymers by simple physical and chemical tests.