DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/B.Sc./CBC&GS/87/2024

It is hereby inform to all concerned that, the Revised syllabi prepared by the Board of Studies/Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, **Academic Council at its meeting held on 08 April 2024 has accepted** the following Syllabi under the Faculty of Science & Technology **as per Norms of Choiced Based Credit Grading System** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1.	BA./B.Sc.Mathematics (Optional)	Vth and VIth semester
2.	B.Sc.Statistics (Optional)	Vth and VIth semester
3.	B.Sc.Horticuluture (Optional)	Vth and VIth semester
4.	B.Sc.Industrial Chemistry(Optional)	Vth and VIth semester

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/2024/26158-66
Date:- 03.05.2024.

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Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,

2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[B.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
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Dr. Babasaheb Ambedkar Marathwada University

Aurangabad -431004 (MS) INDIA

Undergraduate Bachelor Degree Program
in Science (B.Sc.)
Industrial Chemistry (Optional Subject)
(Semester V & VI)

Course Structure and Curriculum
(Outcome based Curriculum)
Choice Based Credit System
(Effective from Academic Year 2024-25)

Dr. Babasaheb Ambedkar Marathwada University
Aurangabad - 431004 (MS) INDIA .

Effective from June - 2024

30.4.2024 30.04.2024 30.03.2024

30/4/2024 30/3/24.

1. **Preamble** - The objective of any programme at Higher Education Institute is to prepare their students for the society at large. **Dr. Babasaheb Ambedkar Marathwada University** proposes to offer a three year a Bachelor Program in Science **(B.Sc.)** with ***Industrial Chemistry*** as a one of the ***optional subjects***. Each year is called an academic year and is divided into two semesters. Thus there will be a total of six semesters. The teaching learning process involves theory classes (Periods) of an hour duration and practical classes of three hours duration. The curriculum will be delivered through various methods including chalk and talk, power point presentations (ICT based), audio, video tools, E-learning/ E-content, virtual laboratories, simulations, field trips/ Industry visits, seminars (talks by experts), workshops, projects, models and class discussions. The assessment broadly comprises of Internal Assessment (Continuous Evaluation-CIA) and End Semester Examination (ESS). Each theory paper carries 50 marks with 20% marks for Internal Assessment and 80% for End Semester Examination. The internal assessment will be through MCQ, test, assignment, oral presentation, worksheets and short projects. The learning outcome based curriculum framework is designed around the CBCS and is intended to suit the present day needs of the students in terms of securing their path towards higher studies or employment in industries.

Introduction to B.Sc. Programme with Industrial Chemistry - The choice based credit system (CBCS) offers flexibility of program structure while ensuring that students gets a strong foundation in the subject and gain in-depth knowledge of all aspects of the field. The new curriculum of ***B.Sc.*** with ***Industrial Chemistry*** offer courses in the areas of organic, inorganic, physical, materials, analytical and industrial chemistry. All the courses are having defined objectives and Learning Outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offers ample skills to pursue research as career in the filed of chemistry and allied areas. The core courses in Industrial Chemistry is designed to familiarize the students with the industrial processes involved in the commercial production of the products. The program also offers wide range of discipline specific electives, skill B.Sc. Industrial Chemistry. The Ability Enhancement and Environmental Science courses are to prepare students to improve their skills required in academic, research and in industrial projects.

Aims of the Bachelors Degree Programme in B.Sc.with Industrial Chemistry - Bachelor course in Industrial Chemistry offers the synergism of basic concepts of Chemistry with Industrial applications. The main objective of this degree course is to produce graduates with enhanced skills, knowledge and research aptitude to carry out higher studies or research and development in the various industrial areas. This degree course of Industrial Chemistry prepares the students for immediate entry to the workplace with sound theoretical, experimental knowledge in the area of fuels and energy, environment, health, foods, cosmetics, pharmaceuticals, polymers, petrochemicals and related multidisciplinary fields. Overall, the course offers basic foundation in chemistry which enables the students to understand the concepts in chemical manufacturing processing, engineering and industrial development.

2. Course Structure & Curriculum for Bachelor of Science (B.Sc.) with *Industrial Chemistry* (Optional Subject) Choice Based Credit System)

B.Sc. (Industrial Chemistry) : Semester V

	Course Code	Course Title	Teaching Time/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional I (DSE-1A) Core Courses **Industrial Chemistry**	IC-511	DSE-1A(1) Core course (Theory **Paper-IX)** (select any one paper from A1/B1/C1/D1. **A1. Unit Processes in Organic Synthesis** **B1 – Industrial Organic Processes**	2 hours	2	50	10	40	20
	IC-512	Core course (Theory **Paper-X)** (select any one paper from A2/B2/C2/D2 **A2. Peocess Equipment Design** **B2 -- Industrial Inorganic Materials**	2 hours	2	50	10	40	20
	IC-521	Lab Course 7 (based on IC-511) **Practicals on Organic Synthesis**	3 hours	1.5	50	10	40	20
	IC-522	Lab Course 8 (based on IC-512) **Design Project on Industrial Processes.**	3 hours	1.5	50	10	40	20
Skill Enhancement Course (SEC-3)	IC-513	SEC-3 Any one skill to be chosen out of two SEC-3(E), SEC-3(F) **SEC-3(E)- Industrial Safety** **SEC-3(F)- Industrial Economics & Management**	2 hours	2	50	10	40	20
Non-Credit Course	XXX-514	**Professional Ethics and Moral Values**	2 hours	2*				
			14	9	250	50	200	100
Total Credits for Semester V: 9 (Theory : 06 ; Laboratory : 3)								

B.Sc. (Industrial Chemistry) : Semester VI								
	Course Code	Course Title	Teaching Time/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional I (DSE-1B) Core Courses **Industrial Chemistry**	IC-611	DSE-1B(1) Core course (Theory **Paper-XI)** (select any one paper from A3/B3/C3/D3. **A3. Unit Processes in In-Organic Synthesis B3 – Fuel Chemistry**	2 hours	2	50	10	40	20
	IC-612	DSE-1B(2) Core course (Theory **Paper-XII)** (select any one paper from A4/B4/C4/D4 **A4. Process Instrumentation B4 --**	2 hours	2	50	10	40	20
	IC-621	Lab Course 9 (based on IC-611) **Practicals on in-organic Synthesis**	3 hours	1.5	50	10	40	20
	IC-622	Lab Course 10 (based on IC-612) **Design Project on Industrial Processes**	3 hours	1.5	50	10	40	20
Skill Enhancement Course (SEC-4)	IC-613	SEC-4 Any one skill to be chosen out of two SEC-4(G), SEC-4(H) **SEC-4(G)- Plant Utilities SEC-4(H)-Air Pollution**	2 hours	2	50	10	40	20
			12	9	250	50	200	100
Total Credits for Semester VI: 09 (Theory : 06 ; Laboratory : 3)								
Total Credits for three years : Sem.I (11.5) + Sem.II (11.5) + Sem.III (15) + Sem IV (15) + Sem. V (09) + Sem VI (09) = 71 Credits.								

3. **Vision**

To develop the department of Industrial Chemistry as center of excellence in all aspects of higher education, research and development of basic technology in Chemical Sciences.

4. **Mission**

To achieve the vision, the department of Industrial chemistry of all affiliated colleges will:

1. Provide a platform for the students with a broad spectrum of diversity to achieve academic excellence with in-built employability in the emerging areas of Industrial Chemistry.
2. Establish a unique learning environment to enable the students to face the challenges in the emerging areas of Industrial Chemistry.
3. Identify the gaps between academics and industry, and design the courses to impart technical and life skills as per the requirements of the region so as to improve employability and develp enterpreneurial capabilities.
4. Adopt a perennial process for bringing excellence in teaching pedagogy by providing ICT based state-of-the –art infrastructural facilitation.
5. Provide a student-centric learning environment and establish a platform for inclusive research leading to the development of creative thought processes amongst students keeping in mind societal needs.
6. Provide ethical and value based education by promoting activities addressing societal needs.

5. **Program Educational Objectives (PEOs)** :

The objectives of B.Sc. (Industrial Chemistry) are as-

PEO 1: Industrial Chemistry graduates will be well prepared for successful careers in the profession or in research & innovation at an industry and/or in government in one or more of discipline of chemistry and /or sub disciplines of Chemistry.

PEO 2: Industrial Chemistry graduates will be academically prepared to provide feasible and sustainable solutions for real-life problems and become licensed professional chemists in due course and will contribute effectively in serving the society.

PEO 3: Industrial Chemistry graduates will be engaged in professional activites to enhance their own achievement and simultaneously contribute in service of humankind.

PEO 4: Industrial Chemistry graduates will be successful in higher education in Chemical Sciences and in management, if persued.

PEO 5: Industrial Chemistry graduates will be successful leaders with quality to handle all kind of diverse circumstances through nurturing them in interdisciplinary and multidisciplinary learning environment.

Programme Outcomes (POs) :

The National Education Policy (NEP) 2020 for India emphasizes several key aspects for Bachelor of Science (B.Sc.) programs, aiming to produce graduates who are not only well-versed in their respective disciplines but also equipped with skills necessary for holistic development and employability. While specific program outcomes may vary between institutions and disciplines within B.Sc. programs, here are some common outcomes aligned with NEP 2020:

PO 1: Scientific Knowledge : Apply knowledge of Chemistry and Chemistry specializations to solution of complex scientific problems.

PO 2: Problem Analysis : Identify, formulate, research literature, and analyze complex scientific problems reaching substantiated conclusions using principles of chemistry.

PO 3: Design /Development of Solutions : Design of solutions for complex scientific problems and design of chemical processes that meet the specified needs with appropriate considerations of public health and safety, and cultural, societal, and environmental considerations.

PO 4: Conduct of investigations comples problems : Use research based methods including design of experiments, analysis and interpretation of data and synthesis of chemical products leading to logical conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern scientific and IT tools including prediction and modelling complex scientific activities with an understanding of limitations.

PO 6: Environment and sustainability: Understand the impact of the professional scientific solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments.

Some of the major attributions of an Industrial Chemistry graduate include:

PO7- Disciplinary Knowledge: In depth knowledge of basic and applied area of Industrial Chemistry. Capability to demonstrate knowledge and understanding of major chemistry concepts, theoretical principles and experimental findings and ability to use modern instrumentation techniques with chemical analysis and separation.

PO8-Communication skills: Excellent communication skills to transmit complex technical information related to chemistry in a clear and concise written and verbal manner as oral presentations and compilation in the form of scientific reports.

PO9- Critical thinking: Able to employ critical thinking and efficient problem solving skills in the basic areas of chemistry (analytical, organic, inorganic, physical and material).Students will become efficient in managerial skills, able to employ critical thinking, analytical reasoning, problems solving and interpretation and documentation of laboratory experiments at a level suitable to succeed at an entrylevel position in chemical industry or a chemistry graduate program. They will be able to identify and explore new areas of research and planning, execute and

report the results of an experiment or investigation, critical thinking and scientific inquiry in the performance, design.

PO10Problem solving: Develop scientific logics and approaches towards problems with critical reasoning.

PO11-Analytical reasoning: Able to enhance the ability to assimilate, discuss scholarly articles and research papers showcasing interdisciplinary areas of Industrial Chemistry and capability for asking questions relating to issues and problems in the field of industrial chemistry.

PO12- Research **related skills**:Will develop ability to scale up chemical products and techniques developed at laboratory to the industrial level.The course will take students beyond chemistry knowledge into the world of industrial Professionals.

7. Program Specific Outcomes (PSO's):

B.Sc. (Industrial Chemistry) Programme Specific Outcomes (PSOs)- After successful completion of three-year degree program in Induatrial chemistry a student should be able to:

PSO 1 : Understand the fundamental concepts, Aspects of industrial chemistry , principles and processes underlying the academic field of Industrial chemistry, its different streams (*Unit operations I & II, Mass transfer, Heat transfer, Fluid mechanisc, Chemical reaction engineering, Industrial safety , process equioment design, Process instrumentation, Plant utilities, and chemical process prinicples)* and its linkages with related disciplinary areas/subjects.

PSO 2 : Demonstrate the procedural knowledge that creates different types of professionals in the field of Industrial chemistry and related fields such as *pharmaceuticals, chemical industry, teaching, research, environmental monitoring, product quality, consumer goods industry, food products, cosmetics industry, polymers & petrochemicals*, etc.

PSO 3 : Employ critical thinking and the scientific method to *design, carry out, record and analyze the results* of Industrial chemistry experiments and get an awareness of the impact of industrial chemistry on the environment and the society.

PSO 4 : Use chemical techniques relevant to *academia and industry, generic skills and global competencies, including knowledge and skills* that enable students to undertake further studies in the field of industrial chemistry or a related field and work in the chemical and non-chemical industry sectors.

PSO 5: Undertake hands on *lab work and practical activities* which develop problem solving abilities required for successful and bright career in industry.

PSO 6 : Understand *safety aspect of chemicals, transfer and measurement of chemicals, preparation of solution* and find out the green route for chemical reaction for sustainable development.

PSO 7 : Create an awareness of the *impact of industrial chemistry on the environment, society and development* outside the scientific community.

8. Eligibility: Candidates seeking admission to the Fifth semester of B.Sc. in Industrial Chemistry must possess the following eligiblity criteria.

a. Must have passed B.Sc.Semester III & IV with Industrial Chemistry (optional subject) .

9. **Duration:** The total duration of the course will be of Six semesters (Three Years).
10. **Medium of Instructions** : English
11. **Choice Based Credit System** (CBCS)

The choice based credit system (CBCS) is going to be adopted by the university. This provides flexibility to make the system more responsive to the changing needs of our students and to suit the present day needs of the students in terms of securing their path towards higher studies or employment in industries. The credit based system also facilitates the transfer of creeits. Students will have to earn 71 credits from Industrial Chemistry optional subject for the award of three year undergraduate degree Bachelor of Science (B.Sc.).

12. **Credit-to-contact hour Mapping**:
    a) One credit woluld mean the equivalent of 15 periods of 60 minutes each for a theory lecture.
    b) For lab course/workshop/internship/field work/project. The credit weightage for equivalent hours shall be 50% that of therory lectures.
13. **Attendance**: Students must have 75 % of attendanace in each course for appearing examination, otherwise he/she wil bestrictly not allowed for appearing the semester examination of each course. Frequent absence from regular lecture/practical course may lead to disqualigfication from continuous inernal assessment (CIA) process in respective subject.
14. **Evaluation Methods/Scheme of Examination, Earning Credits, Grading System.**

Evaluation Methods

- The assessment will be based on 20:80 ratio of continuous internal assessment(CIA) and Semester-end Examination(SEE) . Therewould be combined passingin CIA and SEE. In case of failure in SEE in a particular course(s), the exam will be conducted in an immediate subsequent semester.
- In case a student fails in a certain course(s) in aparticular semester and the same course(s) are modified /revise/removed from the curriculum in due course, the student will have to appear as per the newly framed curriculum and / or pattern in a subsequent semester, at his/her own responsibility.

Continuous Internal Assessment (CIA)

There will be 20 marksfor Continuous Internal Assessment. Two internal tests (20 marks each) will be conducted during the semester as a part of a continuoius assessment. At the end of the semester, an average of two tests will be considered for the calculation of final marks.

Semester End Examination (SEE)

- The semester-end theory examination for each theory Course will be for 40 marks. The total marks shall be 50. (40 Marks of SEE + 10 Marks of CIA)
- Semester-end examination (SEE) time table will be declared by the University (as per the university annual calendar). The paper setting and assessment of theory courses, laboratory courses and research projects will done by external examiners appointed by the university.
- Pattern of semester endexamination question paper will be as below:
  - The semester-end examination of the theory course will have two parts (10+30=40Marks)
  - Part A will be consisting of 5 questions having 2 marks each (multiple chouse questions/fill in the blanks/answer in sentence) as compulsory questions and it should cover entire coursecurriculum (10 marks)
  - Part B will carry 8 questions (06 marks for each question) (02 questions from each of 04 units) and students will have to attempt any 05 questions out of 08 (30 Marks).
  - 20 to 30 % weightage can be given to problems/numerical wherein the use of a non-programmable scientific calculator may be allowed.

Earning Credits

At the end of every semester, a letter grade will be awarded in each course for which a student had registered. A student's performance will be measured by the number of credits that he/she earned by the weightedGrade Point Average (GPA). The SGPA (Semester Grade Point Average) will be awarded after completion of the respective semester anf the CGPA (Cumulative Grade Point Average) will be the final exit.

Grading System

The grading reflects a student-own proficiency in the course. A ten point rating scale shall be used for the evaluation of the performance of the students to provide letter grade for each course and overall grade for the Bachelor Program. Grade points are based on the total number of marks obtained by him/her in all heads of the examination of the course.
The grade points and their equivalent range of marks are shown in Table-1.

Table -1 : Ten Point grade and grade description

Marks Obtained (%)	Grade Point	Letter Grade	Description
91-100	10 (9.01 - 10.00)	O	Outstanding
81-90	9.0 (8.01 - 9.00)	A+	Excellent
71-80	8.0 (7.01 - 8.00)	A	Very Good

61-70	7.0 (6.01 - 7.00)	**B+**	Good
51-60	6.0 (5.01 - 6.00)	**B**	Above Average
41-50	5 (4.01 - 5.0)	**C**	Average
40	4.0	**P**	Pass
< 40	0.0	**F**	Fail
	0.0	**AB**	Absent

- Non-appearance in any examination/assessment shall be treatedas the students have secured zero marks in that subject examination/assessment.
- Minimum P grade (4.00 grade points) shall bethe limit to clear / pass the course / subject. A student with F grade will beconsidered as " failed" in the concerned coursse and he/she has to clear the course by appearing in the nexyt successive semester exasminations.
- Every student shall be awarded grade points out of maximum 10 points in each subject (based on 10 point scale). Based on the grade points obtainedin each subject, Semester Grade Point Average (SGPA) and then Cummulative Grade Point Average (CGPA) shall be computed . Results will be announced at the end of each semester and CGPA will be given at final exit.

Computation of SGPA (Semester Grade Point Average) and CGPA (Cummulative Grade Point Average)

Grade in each subject / course will be calculated based on the summatin of marks obtained in all five modules.

The computation of SGPA and CGPA will be as below :

- Semester Grade Point Average (SGPA) is the weighted average points obtained by the students in a semester and will be computed as follows.

$$SGPA = \frac{\text{Sum(Course Credits) X Number of Grade Points in Concerned course gainde by the students}}{\text{Sum (Course Credits)}}$$

The SGPA will bementioned on the grade card at theendof every semester.

- The Cumulative Grade Point Average (CGPA) will be usedto describe the overall performance of a student in all semester of the course and will be computed asunder –

$$CGPA = \frac{\text{Sum (All Six Semester SGPA)}}{\text{Total Number of Semester}}$$

The SGPA and CGPA shall berounded off to the second place of decimal.

Grade Card - Results will bedeclaredby the University and the grade card (containing the grades obtained by thestudents along with SGPA) will be issued by

the university after completion of every semester. The grade card will be consisting of following details.

- Title of the courses along with code opted by the student.
- Credits associated with the course.
- Grades and grade points secured by the students.
- Total credits earned by the student in a particular semester.
- Total credits earned by the students till that semester.
- SGPA of the student.
- CGPA of the student (at final exit)

Cummulative Grade Card - The grade card showing detail grades secured by the student in each subject inall semester along with overall CGPA will be issuedby the University at final exit.

B.Sc. (Industrial Chemistry) : Semester V

IC-511: A1 : Unit Processes in Organic Synthesis

Total Credits: 2 Theory Paper - IX Contact Hours: 30 (Clock Hours)
Marks: 50

Learning Objectives of the Course: The students are expected to learn -

1.Outline of Organic Industrial Processes-Nitration,
2. Amination by reduction
3. Halogenation
4. Sulfonation & Sulfation
5. Polymerization

Outcomes of the Course :

CO1: The students understood about the basics, mechanism & kinetics of Nitration reaction used in Industry.

CO2: The students acquire knowledge of organic process –Amination by reduction.

CO3: The students known about Halogenation reactions.

CO4: The students understood the sulfonation & sulfating reagents, & different aromatic sulfonation reactions.

CO5: The students are knowing the different types of polymers & technics of polymers,processes.

Course Contents : Unit Processes in Organic Synthesis

Unit I – Nitration - Introduction, Nitrating agent, Aromatic Nitration, Kinetics & Mechanism of aromatic nitration, Nitration of hydrocarbons, Nitrate Esters,N-Nitro Compounds, Process equipment for technical nitration, Batch nitration, Contineous nitration, Mixed acid compositions, DVS calculations, Typical industrial nitration process-Preperation of Nitrobenaene, & m-dinitrobenzene.

Unit II- Amination by Reduction - Introduction, Methods of reduction, Iron & acid reduction, reaction mechanism, Chemical & physixal factors, physical condition of iron, Amount of water used, Addition of solvents, yields of aniline, Equipment material of construction, Agitation, Jacketing of reducers, Manufacturing of aniline & Recovery of Aniline, Distillation of Aniline.

Unit III – Halogenation - Introduction, Chlorination, Bromination, Fluorination, Iodination.

Unit IV- Sulfonation & Sulfation -Introduction, Sulfonation, sulfation agents, sulfonation of aromatic compounds, Benzene & its derivatives, Naphthalene, Anthraquinone derivatives.

Unit V : Polymerization - Introduction, Functionality, Polymerziation, Polycondensation, Addition , Free radical, Ionic Polymerization , Bulk polymerization, Solution polymerization , Emulsion polymerization , Suspension Polymerisation .

Refferance Book:1) Unit Processes in Organic synthesis – P.H.Groggins, 5th edn, Tata Mcgraw-Hill Publishig company limited , New Delhi, 1995 Industrial Chemistry – B.K.Sharma, Goel Publishing House , Meerut, 15 th edn, 2006. Chemical Processes-Shreve's . Polymer Chemistry- Gowarikar, Polymer Chemistry- Billmayer Outlines of Chemical Technology- Gopal Rao, East-West Press, 3 rd edn, 2005.

B.Sc. (Industrial Chemistry) : Semester V
IC-511: B1 : Industrial Organic Processes

Total Credits: 2 Theory Paper - IX Contact Hours: 30 (Clock Hours)
Marks: 50

Learning Objectives of the Course: The students are expected to learn -
1.Outline of Organic Industrial Processes-Oxidation
2. Hydrogenation
3. Esterification
4. Hydrolysis
5. Alkylation

Outcomes of the Course :
CO1: The students understood about the basics, mechanism & kinetics of Oxidation reaction used in Industry.
CO2: The students acquire knowledge of organic process –Hydrogenation
CO3: The students known about Esterfication reactions.
CO4: The students understood the Hydrolysis reactions.
CO5: The students are knowing the different types of Alkylation processes.

Course Contents : Unit Processes in Organic Synthesis

Unit-1 : Oxidation : Types of oxidation, Oxidizing agents, Liquid-Phase Oxidation with Oxygen, Oxidation of ethanol to acetic acid, Oxidation of liquid petroleum hydrocarbons, Oxidation of Methanol, Vapour phase oxidation of aromatic hydrocarbons, Kinetics & thermochemistry, Apparatus for Oxidation for liquid phase reaction.

Unit-2 :Hydrogenation : Defination & scope, Hydrogen: Producation & properties, Hydrogen by electrolysis of water, Properties of Hydrogen, Catalytic Hydrogenation and Hydrogenolysis, Kinetic & thermodynamics of hydrogenation reaction, Apparatus and materials of construction, Industrial Process: Hydrogenation or hardening of fats.

Unit-3 :Esterfication : Introduction, Esterfication by Organic acids, Catalytic Esterification, Esterfication of Carboxilic acid derivatives-Alcaoholysis,Design and Operation of Esterification plants,

Unit-4 :Esterfication : Defination & scope, Hydrolysing agents, Kinetics , thermodynamics and mechanism of hydrolysis, Hydrolysis of carbohydrates, Preparation of Alcohols from olefins, Preparation of Glycerol.

Unit-5 :Alkylation : Introduction, Types of Alkylation, Alkylating agents, Factors controlling alkylation, Equipment for alkylations, Effect of alkylation, Alkyl bound to Carbon, , Alkyl bound to Oxygen, , Alkyl bound to Trivalent Nitrogen.,

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Refferance Book:1) Unit Processes in Organic synthesis – P.H.Groggins, 5th edn, Tata Mcgraw-Hill Publishig company limited , New Delhi, 1995 Industrial Chemistry – B.K.Sharma, Goel Publishing House , Meerut, 15 th edn, 2006. Chemical Processes-Shreve's . Polymer Chemistry- Gowarikar.

B.Sc. (Industrial Chemistry) : Semester V

IC-512: A2 : Process Equipment Design

Total Credits: 02 Theory Paper - X Contact Hours: 30 (Clock Hours)
Marks: 50

Learning Objectives of the Course: The students are expected to learn design & construction the equipments used in industrial processes -

1. Distillation & fractionating equipments .
2. Evaporation & Crystallization
3. Centrifugation & Agitators
4. Reaction Vessel
5. Corrosion

Outcomes of the Course :

CO1: The students understood about the basics & design for equipments used for distillaltion.

CO2: The students acquire knowledge of Equipments used for evaporation & Crystallization.

CO3: The students known about Centrifugation & agitators used in manufacturing process.

CO4: The students understood the reactors used in industry.

CO5: The students are knowing the different types of Corrosion & factors preventing corrosion.

Course Contents : Process Equipment Design

Unit I – Distillation & Fractionating equipments - Introduction, Types of column, Shell, Determination of Shell thickness, Determination height "X", Allowable deflection, Column internal details, Equuillibrium stage column, Differential column.

Unit II- Evaporation & Crystllization- Introduction, Types of evaporators, equipments, & Types of Crystillation, Equipments.

Unit III – Centrifugation & Agitators - Introduction, Types of Centrifugation, Equipments, & Types of Agitators, Baffling.

Unit IV-Reaction Vessel –Introduction, Materials of Construction, classification of reaction vessels, Heating systems, design considerations.

Unit V : Corrosion - Forms of Corrosion , Factors influencing corrosion, Factors preventing corrosion.

Refferance Book: : 1) Process Equipment Design- M.V.Joshi
2) Process Equipment Design- Mahajani & JoshiM.V.Joshi
3) Perry's Handbook of Engineering Chemsitry.

B.Sc. (Industrial Chemistry) : Semester V

IC-512: B2 : Industrial Inorganic Materials

Total Credits: 02 Theory Paper - X Contact Hours: 30 (Clock Hours)
Marks: 50

Learning Objectives of the Course: The students are expected to learn processis in inorganic materials- 1. Surface Coatings, 2. Batteries 3. Alloys 4. Industrial Metallurgy 5. Fertilizers

Outcomes of the Course :

CO1: The students understood about the basics & Industrial process of surface coatings.
CO2: The students acquire knowledge of Batteries & its composition.
CO3: The students known about different types of alloys.
CO4: The students understood the Industrial metallurgy.
CO5: The students are knowing the different types of fertilizers& its process.

Course Content

Unit 1- Surface Coatings -Objectives of surface coatings, preliminary treatment of surface and classification of surface coatings. Paints and pigments - formulation, composition and related properties. Oil paint, Vehicle oils, modified oils, Pigments, toners and lakes pigments, fillers, thinners, enamels, emulsifying agents. Special paints (heat retardant, fire retardant, eco- friendly and plastic paint), wax polish, water and oil paints, additives.Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Unit 2- Batteries -Primary and secondary batteries, battery components and their role and characteristics of battery. Working of following batteries: Pb acid, Li-Battery, solid state electrolyte battery. Fuel Cells, Solar cell and polymer cell.

Unit 3 – Alloys -Classification of alloys, ferrous and non- ferrous alloys, specific properties of elements in alloys.Industrial manufacture of steel. Composition and properties of different types of steel.

Unit 4 -Industrial Metallurgy -Preparation of metals (ferrous and nonferrous) and ultra pure metals for semiconductor technology.

Unit 5 –Fertilizers -Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, ammonium nitrate,calcium ammonium nitrate,ammonium phosphates, superphosphate of lime, potassium chloride and potassium nitrate.

Ref.Books

1. **Industrial Chemistry**, Vol -I, Ellis Horwood Ltd. UK. Stocchi, E.(1990),
2. **Elementary Principles of Chemical Processes**, Wiley Publishers, New Delhi. Felder, R. M.; Rousseau, R. W. (2015),
3. **Introduction to Ceramics**, Wiley Publishers, New Delhi. Kingery, W. D.;Bowen, H. K.;Uhlmann, D. R. (1976),
4. **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi. Jain, P. C.; Jain, M. (2013 Kent, J. A. (ed) (1997),

B.Sc. (Industrial Chemistry) : Semester V

IC-521 : Lab Course 7 (based on IC-511)

Marks : 50 Credits : 1.5

Every candidate appearing for the examination must produce a journal showing that he/she has completed 06 experints during the academic year. The journal must be certified at the end of the semester /year by the Head of the department.

ListofExperimentstobetaken: (Any Six)

1. Preparation of P-nitroacetanilide.
2 Preparation of m-nitrobenzene
3 .Preparation of tri-nitrophenol (Picric acid)
4. Preparation of m-nitroaniline.
5. Preparationn of 3,5 Dinitro benzoic acid from benzoic acid.
6. Preparation of p-bromoaniline.
7. Preparation of P-bromophenyl bromide from p-bromoacetophenone..
8. Preparation of p-bromoacetanilide from Acetanilide.
9. Preparation of P-nitroaniline.
10. Preparation of .2,4,6 tri bromo aniline from aniline.
11. Preparation of m-dinitrobenzene from nitrobenzene.
12. preparation of Chlorobenzoic acid from anthranilic acid
13. Preparation of Polystyrene .
14. Preparation of ^,6 and 6,10 Nylon thread by condensation Polymerization.
15. Preparation of Novalac & resole- thermosetting resin.
16. Preparation of Urea formaldehyde resin.
17. Preparation of polysulphide rubber(Thiokol) .

Ref; Vogel's textb00k of Practical Organic Chemistry- Brain S.Furniss.
Advanced Practical Organic Chemistry,- N.K.Vishnoi, Vikas publishing house pvt.ltd.2nd edn.1996.

B.Sc. (Industrial Chemistry) : Semester V

IC-521 : Lab Course 8 (based on IC-512)

Marks : 50 Credits : 1.5

Design Thesis : ***Industrial Project:** Every student should undergo training Programme for the preparation of thesis on industrial useful chemical/ any other investigatory project, in order to promote innovativeness, under the guidance and supervision of concerned faculty of college.

1. Chemical processes used in Industrial Organic Synthesis- Methyl Alcohol, Ethyl Alcohol (Industrial Alcohol), Sugar Industry, Acetaldehyde, Acetic Acid, Isopropanol, Glycerine, Ethylene Glycol, Acetone , Propanone, Phenol, Formaldehyde, Ethyl Acetate, 1,3 Butadiene etc.

   Chemical processes used in Industrial Inrganic Synthesis- Sulfur and Sulfuric acid, Nitrogen Industries - Ammonia, Nitric acid & Urea,Soda Ash (soidum carbonate- Na2CO3), Caustic Soda (Sodium Hydroxide-NaOH), Soaps & Detergents. Polymer Manufacturing Processes: Polethylene, Polypropylene, Polyvinyl chloride , polysterene, Polycondensation Manufacturig process: phenol-formaldehyde, Epoxy polymers,
2. Internship in industry
3. Industrial Visit.
4. Preparation of report
5. Submission of report
6. Synopsis submission which includes-Brief informatin of –Introduction of technical Industrial product, History, Chemical & physical properties, raw materials, methods of production, manufacturing process description, flowsheet, outlines of material balance, plant layout, plant utilities, Industrial safety, Uses of product, feasibility of process-cost estimation, interest in depreciation, profitability. Etc.

B.Sc. (Industrial Chemistry) : Semester V
Skill Enhancement Course (SEC3)
IC-513 : SEC-3 (E) : Industrial Safety.

Marks : 50 Credits : 2 Teaching time /week : 2 Hours

Unit I : Introduction to Industrial safety: Defination & terms used in context of safety, Accident-Nor reportable & reportable accidents. Hazard, Risk, Acceptance of risk, Responsibilities, Perception of Danger, Job knowledge. Physical factors for Accidents, Accident ration, Safety Training. Role of Supervisor in achieving a high standard of safety. Safety committee, safety competition-safety contests, Safety drives, Safety exhibition & poster.

Unit II : Fire & Explosion- The chemistry of fire, fire triangle, classification of fire. Stages of fire, Causes of industrial fire-Electrical equipment, Smoking. Mechanical fault, welding & gas cutting, sparks, explosives dusts, static spark, Runaway chemical reaction, fire detection –Human observation, fire alarm system.

Unit III : Fire Safety Equipments Fire Extinguishers-Fixed fire fighting system, Portable fire Extingusishers-1) Soda acid type, 2) Dry chemical powder type, 3) Carbon dioxide type 4) Foam type Extinguisher.

Unit IV : Personal Protective Equipments-Personal Protective equipment-Hand protection, Foot protection, Head Protection, Eye protection, Face protection, Skin & Body protection. Protection against Fall, Noise protection,

Unit V : Respiratory protection-Care & Precaution, External air supply type & self contained breathing apparatus, Selection of personal protective equipment.

Reference Books –Introduction to Industrial safety- K.T.Kulkarni(2002) Or Concept & Practices in Industrial Safety-K.T.Kulkarni(2007), Handbook of fire technology-R.S.Gupta Orient Longman publication(1992), Hazzards in Chemical units-C.I.Pandya (Oxford ISH-1991).

B.Sc. (Industrial Chemistry) : Semester V

Skill Enhancement Course (SEC3)

IC-513 : SEC-3 (F) : Industrial Economics & Management.

Marks : 50 Credits : 2 Teaching time /week : 2 Hours

Unit I : Basic Concepts of Industrial Economics &management- Value and Utility, Consumer andProducer Goods, Deemand & Supply.

Unit II : Economics Flow Chart- External Source of Finince, Internal Source of Finance, Comparative Evaluation of Shares and Debentures, Economic flow chart of manufacturing organisation, Sources & Uses of Funds, Fixed Capital and Working Capital.

Unit III : Working Capital – Meaning, Different Versions, Sources, Commercial banks, Avoiding Diversions, Computation requirement, Criteria.

Unit IV : Cost and Cost Accounting : Defination, Cost Classification, Overhead Accounitng , Methods of Absorption, Pricing.

Unit V : Management-Material Management-Introduction, Significance of material management, Profit centre concept, ABC analysis, Economic lot size, Purchase Management.

Ref.Books- Study Material for Vocational Course in Industrial Chemistry-1996.

B.Sc. (Industrial Chemistry) : Semester VI

IC-611: A3 : Unit Processes in Inorganic Synthesis

Total Credits: 02 Marks: 50 Contact Hours: 30 (Clock Hours)

Learning Objectives of the Course: The students are expected to learn - Inorganic Synthesis in chemical industries related to Properties, Method of production, Raw material, Chemical reaction, Process description, Uses

1. Sulfur and Sulfuric acid.
2. Nitrogen Industries - Ammonia, Nitric acid, Urea
3. Soda Ash (soidum carbonate- Na2CO3), Caustic Soda (Sodium Hydroxide-NaOH), Soaps & Detergents.
4. Polymer Manufacturing Processes: Polethylene, Polypropylene, Polyvinyl chloride , polysterene
5. Polycondensation Manufacturig process: phenol-formaldehyde, Epoxy polymers, Butadiene-Styrene copolymer(SBR)

Learning Outcomes of the Course :

CO1: Students understood the Properties, Method of production, Raw material, Chemical reaction, Process description, Uses

CO2. They knows the various methods to be used for synthesis of nitrogen containing inorganic chemicals.

CO3: The students can explain synthesis method of soda ash, caustic soda and soaps with detergents.

CO4: The students knows polymerization processes in polymer industries.

CO5 : The students understand the polycondensation reaction used in polymer industries.

Course Contents :

Unit I : . Sulfur and Sulfuric acid.

Unit II : Nitrogen Industries - Ammonia, Nitric acid & Urea

Unit III : Soda Ash (soidum carbonate- Na2CO3), Caustic Soda (Sodium Hydroxide-NaOH), Soaps & Detergents.

Unit IV : Polymer Manufacturing Processes: Polethylene, Polypropylene, Polyvinyl chloride , polysterene

Unit V : Polycondensation Manufacturig process: phenol-formaldehyde, Epoxy polymers, Butadiene-Styrene copolymer(SBR)

Reference Books: 1. Dryden's Outlines of Chemical Technology- for the 21 century,- M. Gopala Rao, 3rd edn, East West press, 2005. 2. https://en.wikipedia.org/

B.Sc. (Industrial Chemistry) : Semester VI

IC-611: B3 : Fuel Chemistry

Total Credits: 02 Marks: 50 Contact Hours: 30 (Clock Hours)

Learning Objectives of the Course :

The course aims to provide students with a basic scientific and technical understanding of the production, behaviour and handling of hydrocarbon fuels and lubricants, including emerging alternative & renewable fuels. This will enable them to be industry ready to contribute effectively in the field of petroleum chemistry and technology.

Course Outcomes (COs):

- The course covers both conventional petroleum-based fuels, and alternative & renewable fuels, including gaseous fuels.
- The students will learn the chemistry that underpins petroleum fuel technology, will understand the refining processes used to produce fuels and lubricants and will know how differences in chemical composition affect properties of fuels and their usage in different applications.
- The course will also cover origin of petroleum, crude oil, composition, different refining processes employed industrially to obtain different fractions of petroleum. Further, course will cover various alternative and renewable fuels like Biofuels (Different generations), Gaseous Fuels (e.g. CNG, LNG, CBG, Hydrogen etc.).
- The course will also cover fuel product specifications, various test methods used to qualify different types of fuels as well characterization methods.
- Review of energy scenario (Global & India), Energy sources (renewable and non-renewable). Types of Crude Oils, Composition and Properties. Crude oil assay

Couese Content :

Unit 1 - Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.Determination of calorific value by Bomb calorimeter and Junker's calorimeter.

Unit 2 - Coal: Analysis of coal, Proximate and ultimate Analysis, Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydrogasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit 3 - Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Unit 4 - Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Unit 5 - Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Ref .Book : Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK. Stocchi, E.(1990),

B.Sc. (Industrial Chemistry) : Semester VI

IC-612 :A4 : Process Instrumentation

P-XII

Total Credits: 02 Contact Hours: 30 (Clock Hours) Marks : 50

Learning Objectives of the Course:

The students are expected to learn-

1. Temperature measurements
2. Pressure measurements
3. Pressure sensors
4. Level meassurements
5. Liquid density measurement

Learning Outcomes of the Course :

CO1: Students are knowing the different types of thermometers used for temp. measurementsg operations.

CO2: The students knows the various thermometers are used for pressure measurements

CO3: The students knows the sensors used for pressure measurements.

CO4: The students understood the different instruments used for level measurements.

CO5: The students knows the hydrometers used for liquid density measurements.

Course Contents :

1. **Unit I :** Temperature measurements- a) Filled Bulb & Glass Stem Thermometers-Glass sStem thermometers, Filled Thermal System, Liquid filled system, vapour system, gas filled system, b) Bimetallic thermometers, c) Resistance Temperature Detector(RTD's), d) Radiation & Pyrometers.
2. **Unit II** : Pressure measurements – a) Manometers-U tube, well, Inclined & Micromanometers. B) Bourdon & Helical pressures sensors- C bourdon pressure sensor, Spiral Bourdon Sensor, Helical bourdon pressure sensors.
3. **Unit III** : Pressure sensors- Bellows Type pressure sensors-Motion balance absolute pressure, Force balance absolute pressure, Diaphragm or Capsule type sensor, Pressure guages.
4. **Unit IV** : Level meassurementsFlow level Switches, Reed Switch design, Tilt switch, Continuous Float indicators-Pressurized tank, Magnetically coupled indicators.
5. **Unit V :** Liquid density measurement-Hydrometers.

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Reference Books: 1. Process Equipment Design-M.V.Joshi

Proccess Instrumentation – Kirk & Remboy

Process Measurement & Analysis(Instrument Engineers's Handbook, 3rd edn (Butterwork Heinemann publication) –Bela G Liptak .

B.Sc. (Industrial Chemistry) : Semester VI
IC-612: B4

Total Credits: 02 Contact Hours: 30 (Clock Hours) Marks : 50

Learning Objectives of the Course: Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations.

Course outcome

After completion of this course student will be able to
CO1: acquainted with principles of green chemistry,
CO2: know use of environmentally benign solvent
CO3: acquire the knowledge non-conventional techniques used for the synthesis
CO4: understand the different green catalyst for synthesis

Course Content :

Unit I: Introduction to Green Chemistry -What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Unit II- Principles of Green Chemistry and Designing a Chemical synthesis-I
Twelve principles of Green Chemistry with their explanations and examples,

Unit III - Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents. Energy requirements for
reactions – alternative sources of energy: use of microwaves and ultrasonic energy.

Unit IV: Designing a Chemical synthesis-II
Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups. catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

Unit V -Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener
alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes

Reference Books:

1New Trends in Green Chemistry - Ahluwalia, V.K. &Kidwai, M.R., Anamalaya Publishers (2005). .
2. Green Chemistry - Theory and Practical - Anastas, P.T. & Warner, J.K, Oxford University Press (1998).
3.. Introduction to Green Chemistry, - Marcel Dekker (2001).
4.. Real-World cases in Green Chemistry, - Cann, M.C. &Connely, M.E American Chemical Society, Washington (2000).
5. Introduction to Green Chemistry- Ryan, M.A. &Tinnes and, M. American Chemical Society,

B.Sc. (Industrial Chemistry) : Semester VI

IC-621: Lab Course 9 (based on IC-611)

Marks: 50 Credits : 1.5

Every candidate appearing for the examination must produce a journal showing that he/she has completed 06 experints during the academic year. The journal must be certified at the end of the semester /year by the Head of the department.

ListofExperimentstobetaken: (Any Six)

1. Preparation of P-nitroacetanilide.
2. Preparation of m-nitrobenzene
3. .Preparation of tri-nitrophenol (Picric acid)
4. Preparation of m-nitroaniline.
5. Preparationn of 3,5 Dinitro benzoic acid from benzoic acid.
6. Preparation of p-bromoaniline.
7. Preparation of P-bromophenyl bromide from p-bromoacetophenone..
8. Preparation of p-bromoacetanilide from Acetanilide.
9. Preparation of P-nitroaniline.
10. Preparation of .2,4,6 tri bromo aniline from aniline.
11. Preparation of m-dinitrobenzene from nitrobenzene.
12. preparation of Chlorobenzoic acid from anthranilic acid
13. Preparation of Polystyrene .
14. Preparation of 6,,6 and 6,10 Nylon thread by condensation Polymerization.
15. Preparation of Novalac & resole- thermosetting resin.
16. Preparation of Urea formaldehyde resin.
17. Preparation of polysulphide rubber(Thiokol) .

Ref; Vogel's textb00k of Practical Organic Chemistry- Brain S.Furniss.
Advanced Practical Organic Chemistry,- N.K.Vishnoi, Vikas publishing house pvt.ltd.2nd edn.1996.

B.Sc. (Industrial Chemistry) : Semester VI

IC-622: Lab Course 10 (based on IC-612)

Marks: 50 Credits : 1.5

Design Thesis : Design Thesis : ***Industrial Project:** Every student should undergo training Programme for the preparation of thesis on industrial useful chemical/ any other investigatory project, in order to promote innovativeness, under the guidance and supervision of concerned faculty of college.

Chemical processes used in Industrial Organic Synthesis- Methyl Alcohol, Ethyl Alcohol (Industrial Alcohol), Sugar Industry, Acetaldehyde, Acetic Acid, Isopropanol, Glycerine, Ethylene Glycol, Acetone , Propanone, Phenol, Formaldehyde, Ethyl Acetate, 1,3 Butadiene etc.

Chemical processes used in Industrial Inrganic Synthesis- Sulfur and Sulfuric acid, Nitrogen Industries - Ammonia, Nitric acid & Urea,Soda Ash (soidum carbonate-Na2CO3), Caustic Soda (Sodium Hydroxide-NaOH), Soaps & Detergents. Polymer Manufacturing Processes: Polethylene, Polypropylene, Polyvinyl chloride , polysterene, Polycondensation Manufacturig process: phenol-formaldehyde, Epoxy polymers, Butadiene-Styrene copolymer(SBR), etc.

1. Internship in industry
2. Industrial Visit.
3. Preparation of report
4. Submission of report & thesis
5. Synopsis submission which includes-Brief informatin of –Introduction of technical Industrial product, History, Chemical & physical properties, raw materials, methods of production, manufacturing process description, flowsheet, outlines of material balance, plant layout, plant utilities, Industrial safety, Uses of product, feasibility of process-cost estimation, interestm depreciation, profitability. Etc.

B.Sc. (Industrial Chemistry) : Semester VI

Skill Enhancement Course (SEC-4)

IC-613 : SEC-4 (G) : Plant Utilities.

Marks : 50 Credits : 2 Teaching time /week : 2 Hours

Unit I : Water : Sources of water, Hard & soft water, Causes of hardness , Disadvantages of hard water, Methods of softening of water, Preboiling of water-lime soda process, Ion exchange process, Essential Charachteristics of drinking water.

Unit II : Treatment & Purification of water : Screening, Sedimentation, Coagulation, Filtration, Treatment to Boiler Feed water, Formation of scale, Corrosion, Priming & Foaming , Caustic embrittlement.

Unit III : Insulation –Introduction, insulating factors, properties of good insulator, classification- Glass, wool properties & application, Thermocole properties & application, Cold insulation, low Temperature insulation.

Unit IV : Steam & Steam Generator : Steam-formation of steam at constant pressure, Enthalpy-Enthalpy of water, Enthalpy of Evaporation, Enthalpy of dry saturated steam, Steam Generator-Classification, Factors for Boiler selection.

Unit V : Air- Compressed air, Fan air, Reciprocating , Air Compressors, Multistage Compressors, Rotary Compressors.

Reference Books – Process Instrumentation_ Kirk & Remboy

Process Measurement & Analysis-Bela G. Liptak

Plant Utilities- D.B.Dhone , Nirali Prakashan, pune.

B.Sc. (Industrial Chemistry) : Semester VI

Skill Enhancement Course (SEC-4)

IC-613 : SEC-4 (H) : Air Pollution

Marks : 50 Credits : 2 Teaching time /week : 2 Hours

Unit I : Introduction- Segments of Environment- Atmosphere, Hydrosphere, Lithosphere, Biosphere,

Unit II: -Composition of Air, Chemical reactions occuring in air due to sunlight-reactions in Troposphere, reactions of air in Stratosphere, reactions of air in Mesosphere and Ionosphere.

Unit III : Sources of air Pollution, Units of measurement of air pollutants-Oxides of Nitrogen (Nox), reactions of Nox in the Atmosphere, Effects of Nox, Control of Nox, Oxidation of Sulphur (SOx), Reaction of SOx in the Atmosphere, Effect of SOx, Control of SOx, Oxides of Carbon (COx), Sources of Cox, Effect of Cox, Control of COx

Unit IV : Green House Effect-How the green house effect produced, Major sources of green house gases.

Unit V : Analysis of Air Pollutants- Measurement o Air Quality- Units, Sampling, Devices and methods for Sampling.

Reference Book: Industrial Chemistry-b.K.Sharma , Goel Publishing House, Meeret,15th edn, 2006.

Reference Books:

1. IndustrialChemistry:anintroduction:D.A.Skoog,D.M.WestandF.J.Holler,Saunders College publishers, 6th edition.
2. AnintroductiontoIndustrialChemistry,S.A.Iqbal,M.Satake,Y.MidoandM.S.Shethi.
3. College Industrial Chemistry: Joshi, Baliga and Shetty, Himalaya Publishinghouse.
4. Qualitative analysis: Day andUnderwood.
5. Qualitative inorganic analysis: A. I.Vogel.
6. Principles of Industrial Chemistry: Pandit andSoman.
7. Anayltical chemistry, G. D. Christian, J. Wiley eastern pressLtd.
8. Industrial Chemistry: AlkaGupta.
9. Basic concepts of Industrial Chemistry: S. M.Khopkar.
10. Advanced practical organic chemistry:Vishnoi.
11. Qualitative analysis: A laboratory manual: Day andUnderwood.
12. Fandamentals of Industrial Chemistry: D. A. Skoog, D.M. West and H. J. Holler, 7th edition.
13. Industrial Chemistry principles: J. H. Kennedy, W. B. S. Saunders pub.Ltd.
14. Industrial Chemistry: Principles and Techniques: L. G. Hargis, PrenticeHall.
15. Principles in semi-micro qualitative analysis: G. R. Chatwal edited by M.Arora.
16. Experiments in chemistry: D. V.Jahagirdar.
17. A text book of experimental and calculation in engineering chemistry: S. S.Dara.
18. Industrial Chemistry: Pitrzyk and Frank, secondedition.
19. Modern Industrial Chemistry: W. F. Pickering, Marcel Decker INC. NewYork.
20. Introduction to chromatography: Srivastava andSrivastava.
21. University Practical Chemistry by PC Kamboj, Vishal Publishing Company,Jalandhar.
22. Food Chemistry by L.W. Aurand and A.E. woods the AVI PublisingInc.
23. Food Chemistry by L.H. Meyer, AffliatedEast- West press Ltd, NewDelhi.
24. Foods- Facts and principles by N. Shakuntala Manay, M. ShdaksharaSwamy.
25. Principles of Food Chemistry by John M.deMan.
26. Principles of Food Science, Part I,Food Chemistry edited by Owen R. Fennama , Mareal Dekker, Inc., NewYork.
27. Hand book of Food and Nutrition by M.Swaminathan
28. Practical Chemistry (for B.Sc.I, II & III Year Students of All Indian Universities) Dr.O.P.Panday, D.N. Bajpai & Dr. S. Giri, S.Chand& Company, NewDelhi.
29. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis,ELBS.
30. Khosla,B.D.;Garg,V.C.&Gulati,A.SeniorPracticalPhysicalChemistry,R.Chand& Co.: New Delhi(2011).
31. Garland,C.W.;Nibler,J.W.&Shoemaker,D.P.ExperimentsinPhysicalChemistry8th Ed.; McGraw-Hill: New York(2003).
32. Halpern,A.M.&McBane,G.C.ExperimentalPhysicalChemistry3rdEd.;W.H.Freem an & Co.: New York(2003)
33. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education(2009)
34. Furniss,B.S.;Hannaford,A.J.;Smith,P.W.G.;Tatchell,A.R.PracticalOrganicChemis try, 5th Ed., Pearson(2012)
35. Khosla,B.D.;Garg,V.C.&Gulati,A.,SeniorPracticalPhysicalChemistry,R.Chand&

Co.: New Delhi(2011).
36. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi(2001).
37. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University ofDelhi.
38. Arthur, I. V. Quantitative Organic Analysis,Pearson.
39. Garland,C.W.;Nibler,J.W.&Shoemaker,D.P.ExperimentsinPhysicalChemistry8th Ed.; McGraw-Hill: New York(2003).