

**DEEN DAYAL UPADHYAYA GORAKHPUR UNIVERSITY**  
**GORAKHPUR**



**FOUR YEAR OF**  
**B. Sc. INDUSTRIAL CHEMISTRY Programme**  
(B.Sc. IC- Honours and Research Programme)  
**Syllabus**  
(For Academic Session 2024 onwards)

## Semester-wise Titles of the Papers in B.Sc. Industrial Chemistry

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits	
<b>Certificate in Materials and techniques in Chemical Industries</b>						
1	I	ICH 101F	Fundamentals of chemistry	Theory	4+0	
		ICH 102F	Basic analytical methods	Practical	0+2	
		SECC-01F	Laboratory tools and techniques	SECC	3+0	
		AECC-01F	Academic writing	AECC	2+0	
	II	ICH 103F	Material Science and techniques in Chemical Industries	Theory	4+0	
		ICH 104F	Materialistic analysis	Practical	0+2	
		SECC-02F	Industrial Processes	SECC	3+0	
		AECC-02F	Personality Development and Leadership	AECC	2+0	
<b>Diploma in Industrial instrumentation and chemical analysis</b>						
2	III	ICH 201F	Process Instrumentation and Industrial chemical analysis	Theory	4+0	
		ICH 202F	Industrial chemical and Instrumental analysis	Practical	0+2	
		SECC-03F	Environmental studies and Computer application	SECC	3+0	
		AECC-03F	Industrial Waste Management	AECC	2+0	
	IV	ICH 203F	Process Chemistry	Theory	4+0	
		ICH 204F	Qualitative and Synthetic methods	Practical	0+2	
			CHE-205F	Research Project	SECC	3+0
			AECC-04F	Occupational Health Management	AECC	2+0
<b>B.Sc in Industrial Chemistry</b>						
3	V	ICH 301F	Industrial Chemicals	Theory	4+0	
		ICH 302F	Pollution, its management and industrial economics	Theory	4+0	
		ICH 303F	Industrial chemicals and pollution management		0+2	
	VI	<b>Polymer Science</b>				
		ICH 305F	Synthetic polymer	Theory	4+0	
		ICH 306F	Polymerization techniques and characterization	Theory	4+0	
		ICH 307F	Synthesis and analysis of polymers	Practical	0+2	
<b>Pharmaceutical Chemistry</b>						
	Or	ICH 309F	Pharmaceutical and Phytochemicals	Theory	4+0	
		ICH 310F	Drugs and its manufacturing	Theory	4+0	
		ICH 311F	Experimental Pharmaceutical chemistry	Practical	0+2	
<b>Agrochemicals</b>						
	Or	ICH 313F	General and halogenated insecticides	Theory	4+0	
		ICH 314F	Fungicides and herbicides	Theory	4+0	
		ICH 315F	Analysis of agrochemicals	Practical	0+2	

**B.Sc. Industrial Chemistry (IC) Honours and Research-**

**VII and VIII Semester**

**B.Sc. VII Semester-**

**(B.Sc. IC Honours) and (B.Sc. IC Research)**

<b>Paper No.</b>	<b>Paper Name</b>	<b>No. of Credits</b>
ICH-401F	Physical Chemistry	4+0
ICH -402F	Inorganic Chemistry-I	4+0
ICH -403F	Organic Chemistry-I	4+0
ICH -404F	Basics of Medicinal Chemistry	4+0
ICH -405F	Practical	0+4

**B.Sc. VIII Semester (B.Sc. IC Honours)**

<b>Paper No.</b>	<b>Paper Name</b>	<b>No. of Credits</b>
ICH -406F	Analytical Chemistry-I	4+0
ICH -407F	Inorganic Chemistry-II	4+0
ICH -408F	Organic Chemistry-II	4+0
ICH -409F	Medicinal Chemistry	4+0
ICH -410F	Practical	0+4

**B.Sc. VIII Semester (B.Sc. IC Research)**

<b>Paper No.</b>	<b>Paper Name</b>	<b>No. of Credits</b>
ICH -406F	Analytical Chemistry-I	4+0
ICH -407F	Inorganic Chemistry-II	4+0
ICH -412F	Research Project	0+12

### Appendix-A (Four Year UG Programme Framework)

Year	Semester	MAJOR-1 [Subject-1] From Same Faculty	MAJOR-2 [Subject-2] From Same Faculty	MINOR [Subject-3] From Same/ others Faculty	SEC Skill Enhancement Course/ vocational	AEC Ability Enhancement Courses/ CoCurricular	Research Project/ Dissertation/ Internship/ Field work/ survey	Total Credits	Degree and Credits
1	I	Th (6 ) OR Th (4)+ Prac (2)	Th (6 ) OR Th (4)+ Prac (2)	Th (6 ) OR Th (4)+ Prac (2)	S.E.C.-1 (3 Credits)	AEC-1 (2 Credits)		23	Certificate in Faculty (46 Credits)
	II	Th (6 ) OR Th (4)+ Prac (2)	Th (6 ) or Th (4)+ Prac (2)	Th (6 ) OR Th (4)+ Prac (2)	S.E.C.-2 (3 Credits)	AEC-2 (2 Credits)		23	
2	III	Th (6 ) OR Th (4)+ Prac (2)	Th (6 ) or Th (4)+ Prac (2)	Th (6 ) OR Th (4)+ Prac (2)	S.E.C.-3 (3 Credits)	AEC-3 (2 Credits)		23	Diploma in Faculty (92 Credits)
	IV	Th (6 ) OR Th (4)+ Prac (2)	Th (6 ) OR Th (4)+ Prac (2)	Th (6 ) OR Th (4)+ Prac (2)		AEC-4 (2 Credits)	Any one (3 Credits)	23	
3	V	Th (2x5 ) OR Th (2x4) + Prac (2)	Th (2x5 ) OR Th (2x4) + Prac (2)					20	UG Degree (132 Credits)
	VI	Th (2x5 ) OR Th (2x4) + Prac (2)	Th (2x5 ) OR Th (2x4) + Prac (2)					20	

4	VII	Th (5x4) OR Th (4x4)+ Prac(4)						20	UG Honors (172 Credits)
	VIII	Th (5x4) OR Th (4x4)+ Prac (4)						20	

OR  
For Students who secured 75% Marks in First Six Semesters

4	VII	Th (5x4) OR Th (4x4)+ Prac(4)						20	UG Honors with Research (172 Credits)
	VIII	Th (2x4)				Research Project (12 Credits)		20	

## **Purpose of the Program**

Industrial chemistry has assisted in the discovery and development of new and improved synthetic fibres, paints, adhesives, drugs, cosmetics, electronic components, lubricants and thousands of other products, and improved processes for oil refining and petrochemical processing that saves energy and reduces pollution. The purpose of the undergraduate Industrial chemistry program at the university and college level is to provide the key knowledge base, laboratory resources and industrial knowledge to prepare students for careers as professionals in various industries and research institutions. This program is designed to prepare students with the lab experience necessary to build a career in chemistry along with the theoretical underpinnings and supporting knowledge needed to advance in such a career.

## **Program's Outcomes**

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in analytical, inorganic, organic and physical chemistries and various industrial process.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
5. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
6. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
7. Students will be able to function as a member of an interdisciplinary problem solving team.
8. Industries in India and throughout the entire world are using increasingly sophisticated chemical procedures, processes, and instrumentation. Consequently, industrial leaders are becoming more concerned about health hazards and safety factors. These companies need chemists and chemical professionals that are experienced and ready to work.
9. Graduates find jobs in a variety of industries, including chemical, plastics, pharmaceutical, environmental, paint, food, automotive, petroleum and personal care products.

<b>PROGRAM SPECIFIC OUTCOMES (PSOS)</b>	
<b>Certificate in Materials and techniques in Chemical Industries</b>	
<b>First Year</b>	<p>Certificate in Materials and techniques in Chemical Industries will give the student a basic knowledge of all the fundamental principles of chemistry like chemical calculations, thermodynamics, chemical equilibrium, liquid crystals, solid state, Atomic structures, Periodic properties of more than 111 elements, Metallurgical operations, various concepts of acid and acids, bases, redox reactions, fundamentals of organic chemistry and catalysis. This course also provide practical knowledge of good laboratories practice (GLP) and various basic analytical methods. This course provides basic knowledge of advanced materials, ceramics, surface chemistry, crystallization, X-ray powder diffraction, Distillation, Evaporation, Absorption, Filtration, Extraction, Drying and purification of organic compounds.</p> <p>Student will be able to do to qualitative and quantitative in the laboratory. This certificate course is definitely going to prepare the students for various fields of chemistry and will give an insight into all the branches of chemistry and enable our students to join the knowledge and available opportunities related to chemistry in the government and private sector services particularly in the field of food safety, health inspector, pharmacist etc. Have a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.</p>
<b>Second Year</b>	<p><b>Diploma in Industrial instrumentation and chemical analysis</b></p> <p>Diploma in industrial instrumentation and chemical analysis techniques will provide the theoretical as well as practical knowledge of instrumental methods of analysis such as chromatography, instruments used in measuring of temperature, pressure, liquid levels, and modern spectroscopic methods. This course also provide sound knowledge of industrial analysis, effluent treatment waste water management, testing of materials, analysis of water, analysis of industrial chemicals, and various chemical process in chemical industries. The knowledge various instruments, spectroscopic tools and separation technique will make the students skilled to work in industries. Students will Achieve the skills required to succeed in the various chemical industry like cement industries, agro product, paint industries, rubber industries, petrochemical industries, food processing industries, pollution monitoring and control agencies etc. Students would get the exposures of a breadth of experimental techniques using modern instrumentation. Monitoring of environmental pollution problems of atmospheric sciences, water chemistry and soil chemistry and design processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations</p>
<b>Third Year</b>	<p><b>B.Sc in Industrial Chemistry</b></p> <p>Degree in industrial Chemistry programme aims to introduce very important aspects of modern day course curriculum, namely, instrumental instrumentation, chemical analysis, pollution monitoring, industrial chemicals, process chemistry and various physical process. Fifth semester of this program provide the basic theoretical and experimental knowledge of pollution management, industrial chemical pollution management and it's economics. This program will provide specialization in Pharmaceutical chemistry or polymer chemistry or agrochemicals and bio fertilizers.</p>
	<p><b>B.Sc. Industrial Chemistry (Honours and Research)</b></p>
<b>Fourth Year</b>	<p>Upon completion of a degree, industrial chemistry students are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program. Various research institutions and industry people in the pharmaceuticals, polymers, petroleum agrochemicals and fertilizer industry sectors will surely value this course.</p>

**Semester-I**  
**Paper-1 (Theory)**  
**Course Title: Basic concepts of Chemistry**

Programme/Class: <b>Certificate in Materials and techniques in Chemical Industries</b>		Year: First	Semester: First
Paper-1 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 101F		Course Title: <b>Basic concept of chemistry</b>	
<b>Course outcomes:</b> Students gain knowledge and skills related to this paper is as follows. Fundamentals of chemical calculations, Heat, thermodynamics and chemical equilibrium, Liquid crystals and Solid state, Atomic Structure and Periodic properties, Metallurgical operations, metals and alloys, Acids and bases, Fundamental of organic chemistry and catalysis, Organic compounds and Nomenclature.			
<b>Credits: 4</b>		<b>Core: Compulsory</b>	
Max. Marks: 25+75=100		Min. Passing Marks:	
<b>Total No. of Lectures: 60h</b>			
Unit	Topics		No. of Lectures
<b>I</b>	<b>Fundamentals of Chemical calculations:</b> Atomic weight, molecular weight, equivalent weight, mole concept, percentage yield, composition of liquid mixtures and gaseous mixtures, molarity, molality, normality.		4h
<b>II</b>	<b>Heat, thermodynamics and chemical equilibrium:</b> Heat capacity of pure gases and gaseous mixtures at constant pressures, sensible heat changes in liquids, Enthalpy changes, entropy. Thermodynamic laws, processes and functions, free energy, partial molar quantities, activity, activity co-efficients, fugacity. Thermodynamic criteria and equilibrium constant, effect of temperature and pressure on equilibrium constants in gaseous system (formation of ammonia).		8h
<b>III</b>	<b>Liquid crystals and Solid state</b> Classification and molecular arrangements, Liquid state, Density, Diffusion, Viscosity, evaporation. Surface tension, effect of temperature and pressure on surface tension, parachor - definition and applications. Crystal lattices, Laws of crystallography, crystal systems, unit cell, space lattice.		8h
<b>IV</b>	<b>Atomic Structure and Periodic properties</b> Quantum numbers, Pauli exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle, Electronic configurations of elements. Types of radii (covalent, crystal and Vander Waal's radii), Electron affinity, Electronegativity and Ionization potential. Pauling scale, Mulliken electronegativity scale, Allred and Rochow scale, Diagonal relationship with examples, Summary of horizontal, vertical and diagonal relationships in the periodic table.		8h
<b>V</b>	<b>Metallurgical operations, metals and alloys:</b> Pulverization, calcination, roasting, refining, principles of extraction of metals, extraction of iron and copper from their ores. Important metals and alloys; mechanical and chemical properties of lead, nickel, iron, titanium and their alloys and their applications.		8h

<b>VI</b>	<b>Acids and bases:</b> Lowery - Bronsted concept, Lewis concept, hard and soft acids and bases, Lux- Flood acids and bases. Theories of indicators, acid-base, redox, metal ion and adsorption indicators and choice of indicators.	7h
<b>VII</b>	<b>Fundamentals of organic chemistry and catalysis:</b> Cleavage of bonds (Homolysis and Heterolysis), Reaction intermediates (carbocation, carbanion and free radicals), Electrophiles and nucleophiles, Aromaticity: benzenoids and Hückel's rule, Inductive effect, Electromeric effects, Mesomeric effect, Resonance, Hyperconjugation and steric effect, Tautomerism, Isomerism, Elementary ideas of stereochemistry, Cracking, Reforming and Hydro forming. Homogeneous and heterogeneous catalysis, basic principles, mechanisms, factors affecting the performance, enzyme catalysed reactions, industrially important reactions.	9h
<b>VIII</b>	<b>Organic compounds and Nomenclature:</b> Classification of organic compounds, Functional group, Aliphatic compound, Aromatic compound, Heterocyclic compound, Petroleum, Natural gas, crude oil, Generic and trade names of simple aliphatic compounds (alicyclic & cyclic), aromatic compounds, Polyfunctional compounds, heterocyclic compounds.	8h

**Suggested Readings:**

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
6. Singh J., Yadav L.D.S., Advanced Organic Chemistry, Pragati Edition
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Carey, F. A., Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
9. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
10. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.
11. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
12. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003
13. Francis, P. G. Mathematics for Chemists, Springer, 1984

**Note:** For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

**Suggested online links:**

<http://heecontent.upsdc.gov.in/Home.aspx>

<https://nptel.ac.in/courses/104/106/104106096/>

<http://heecontent.upsdc.gov.in/Home.aspx>

<https://nptel.ac.in/courses/104/106/104106096/>

<https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>

<https://nptel.ac.in/courses/104/103/104103071/#>

**This course is compulsory for the students of following subjects: Chemistry in 12th Class**

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

**Or**

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (Average of all 04 tests)	(10 marks)
Overall performance throughout the semester, discipline, participation in different activities.	(05 marks)

Course prerequisites: To study this course, a student must have had the subject chemistry in class/12<sup>th</sup>.



Suggested equivalent online courses: .....
Further Suggestions: .....

**Semester-I**  
**Paper-2 (Practical)**  
**Course Title: Quantitative analysis**

Programme/Class: <b>Certificate in Materials and techniques in Chemical Industries</b>	Year: First	Semester: First
Paper-2 Practical		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 102F	Course Title: <b>Basic concept of chemistry</b>	
<b>Course outcomes:</b> Students gain knowledge and skills related to this paper is as follows.		
<b>Credits: 2</b>		<b>Elective</b>
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Practical classes: 60		
Unit	Topics	No. of Lectures
<b>I</b>	<b>Good laboratory practices, Calibration of thermometers and burets</b>	5
<b>II</b>	<b>Simple laboratory techniques:</b> Crystallization, fractional crystallization, distillation, fractional distillation, melting point and boiling point determination.	10
<b>III</b>	<b>Viscosity and Surface Tension of liquids:</b> Determination of relative viscosity of a liquid with water and determination of % composition of an unknown solution. Determination of the surface tension of an organic liquid and determination of % composition of an unknown mixture.	15
<b>IV</b>	<b>Preparation of standard solutions:</b> 1. Preparation of standard solution of $K_2Cr_2O_7$ . To find out the concentration of unknown $K_2Cr_2O_7$ solution using $Na_2S_2O_3$ solution as an intermediate. 2. Preparation of standard solution of copper sulphate. To find out the concentration of unknown copper sulphate solution using $Na_2S_2O_3$ solution as an intermediate. Preparation of standard $KMnO_4$ and ferrous ammonium sulphate solution. To find out the strength of unknown ferrous ammonium sulphate solution using as an intermediate	30
<b>Suggested Readings:</b> 1. Saxena Ruchi, Srivastava Alok Kumar, "Read & Do Practical Chemistry", Kitab Mahal, New Delhi, India, 2016. 2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009. 3. Khopkar, S.M. <i>Basic Concepts of Analytical Chemistry</i> . New Age International Publisher, 2009.		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject chemistry in class/12 <sup>th</sup> .		

Suggested equivalent online courses: .....
Further Suggestions: .....

**Semester-II**  
**Paper-1 (Theory)**  
**Course Title: Material Science and techniques in Chemical Industries**

Programme/Class: <b>Certificate in Materials and techniques in Chemical Industries</b>	Year: First	Semester: Second
Paper-1 Theory		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 103F	Course Title: <b>Material Science and techniques in Chemical Industries</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows, Surface chemistry and Interfacial phenomena, Catalysis, Metals and alloys, Cement, Ceramics and Corrosion, Polymer, Glass, Advanced materials and Material balance, Material balance without chemical reactions, Material balance involving chemical reactions.		
<b>Credits: 4</b>		Core: Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures: 60		
Unit	Topics	No. of Lectures
<b>I</b>	<b>Advanced materials and Material balance:</b> Nanomaterials, superconductors, Biomaterials and Fullerenes  <b>Material balance involving chemical reactions:</b> Concepts of stoichiometric equations, limiting reactant, excess reactant, percent excess, conversion, yield.	09h
<b>II</b>	<b>Surface chemistry and Ceramics:</b> Adsorption isotherm, Sols, Gels, Emulsions, Micro emulsions, Micelles, Aerosols, Effect of surfactants, Hydrotropes. Introduction of ceramics, types, manufacturing processes and applications of ceramics.	08h
<b>III</b>	<b>Utilities in chemical industry:</b> (i) A brief idea about water, steam and air boilers used in chemical industries (ii) A brief idea about Fans, blowers, compressors and vacuum pumps, reciprocating pumps, gear pumps, centrifugal pumps, ejectors used in chemical industries. (iii) Heat exchangers: shell and tube type, finned tube heat exchangers, plate heat exchangers, refrigeration cycles.	08h
<b>IV</b>	<b>Crystallization:</b> Equilibrium solubility, supersaturation, definition, nucleations, crystallization, equipment-tank crystallizer and circulating liquid evaporator crystallizer.	08h
<b>V</b>	<b>X-ray powder diffraction and pharmaceuticals:</b> Introduction, Different Solid Forms and their role in Drug Development, Identification and	09h

	characterization of polymorphs, salts, solvates, co-crystals, Characterization of amorphous materials.	
<b>VI</b>	<b>Distillation, Evaporation and Absorption:</b> (i) Batch and continuous distillation, Azeotropic and Extractive distillation. (ii) Evaporator Equipments; short tube evaporator and forced circulation evaporators. (iii) Equipments: Tray (Plate) towers for absorption, packed towers for absorption.	06h
<b>VII</b>	<b>Filtration, Extraction and Drying:</b> (i) Filter media and filter aids, filtration equipments- bed filters, plate and frame press filters, rotary drum filter and centrifuges. (ii) Extraction Equipments: spray column and packed column extraction, rotating disc column extractors, liquid-liquid extraction, acid-base extraction. (iii) Purpose of Drying, free and equilibrium Moisture of a substance, equipments- tray dryer, rotary dryer, flask dryer, fluid bed dryer, drum dryer, spray dryer and drying solvents.	06h
<b>VIII</b>	<b>Purification of organic compounds:</b> Simple crystallization, fractional crystallization, sublimation, simple distillation, fractional distillation, distillation under reduced pressure, steam distillation, azeotropic distillation. Purification of organic compound by carbon treatment to remove colour impurity.	06h
<b>Suggested Readings:</b> <ol style="list-style-type: none"> <li>1. Nanostructures and Nanomaterials: Synthesis, Properties &amp; Applications by Guozhong Cao, Imperial college Press, London.</li> <li>2. Materials Science and Engineering: An Introduction by William D. Callister and David G. Rethwisch, John Wiley &amp; Sons.</li> <li>3. Industrial Chemistry, E. R. Riegel Reinold Publishing Corp. Bombay.</li> <li>4. Elements of Ceramics, Northern Addison Wesley Publishing Corp.</li> <li>5. mmmm</li> <li>6. <a href="https://onlinelibrary.wiley.com/iucr/itc/Ha/ch7o5v0001/ch7o5.pdf">https://onlinelibrary.wiley.com/iucr/itc/Ha/ch7o5v0001/ch7o5.pdf</a></li> <li>7. <a href="https://link.springer.com/content/pdf/10.1007/s41745-017-0026-4.pdf">https://link.springer.com/content/pdf/10.1007/s41745-017-0026-4.pdf</a></li> </ol>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-II**  
**Paper-2 (Practical)**  
**Course Title: Materialistic analysis**

Programme/Class: <b>Certificate in Materials and techniques in Chemical Industries</b>		Year: First	Semester: First
Paper 2 Practical		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 104F		Course Title: <b>Materialistic analysis</b>	
<b>Course outcomes:</b> Students gain knowledge and skills related to this paper is as follows. Molecular weight determination, Extraction process, Refractometer, Chromatography, Polari-meter.			
<b>Credits: 2</b>		<b>Elective</b>	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Practical classes: 60 Hours			
Unit	Topics	No. of Lectures	
<b>I</b>	Molecular weight determination by depression in freezing point and elevation in boiling points.	10h	
<b>II</b>	<b>Extraction process:</b> Phase diagram, partition coefficient. To find out the partition coefficient of – Iodine between CCl <sub>4</sub> and water Acetic acid between water and benzene.	10h	
<b>III</b>	<b>Refractometer:</b> Determination of Refractive Index of a liquid by Abbe's refractometer. Determination of Molar refractivity and specific refractivity of a liquid by using Abbe's refractometer.	20h	
<b>IV</b>	<b>Chromatography:</b> Column, paper, thin layer To separate and identify the amino acids by ascending paper chromatography. To separate and identify the organic compound by the use of thin layer chromatography. Separation of a mixture of dyes by column chromatography.	20h	
<b>V</b>	<b>Polari-meter:</b> Determination of the specific rotation of sucrose solution.		
<b>Suggested Readings:</b> 4. Author Sir name, Initials, "Book Title", Publisher name, City/country of publication, Year of publication. Edition No. if any. 5. Author Sir name, Initials, "Book Title", Publisher name, City/country of publication, Year of publication. Edition No. if any. 6. Suggestive digital platforms web links-			
This course can be opted as an elective by the students of following subjects: Open for all .....			
Suggested Continuous Evaluation Methods: .....			
Course prerequisites: To study this course, a student must have had the subject chemistry in class/12 <sup>th</sup> .			
Suggested equivalent online courses: .....			
Further Suggestions: .....			

**Semester-III**  
**Paper-1 (Theory)**

**Course Title: Process Instrumentation and Industrial chemical analysis**

Programme: <b>Diploma in Industrial instrumentation and chemical analysis</b>	Year: Second	Semester: Third
Paper-1 Theory		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 201F	Course Title: <b>Process Instrumentation and Industrial chemical analysis</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Instrument for Chromatography studies, Temperature measuring instruments, Pressure measuring instruments, Liquid level measuring instruments, Industrial analysis, Modern instrumental methods of analysis, Effluent treatment & Waste water management.		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0 or 3-1-0 Etc.		
Unit	Topics	No. of Lectures
<b>I</b>	<b>Instrument for Chromatography studies:</b> Principles, methods and applications of paper chromatography, TLC, GLC, HPLC, GLC and GPC.	07h
<b>II</b>	<b>Temperature measuring instruments:</b> Glass thermometers, bimetallic thermometer, pressure spring thermometer, vapour field thermometers, resistance thermometers and radiation pyrometers.	06h
<b>III</b>	<b>Pressure measuring instruments:</b> Manometers, barometers, bourdan pressure gauge; below type, diaphragm type pressure gauges, macleod gauges, pirani gauges etc.	07h
<b>IV</b>	<b>Liquid level measuring instruments:</b> Direct-indirect level measurements, Float type liquid level gauge, ultrasonic level gauges; bubbler system, viscosity (Ostwald viscometer and Ubbelohde viscometer), surface tension (stalagmometer) and density (pycnometer) measurement.	10h
<b>V</b>	<b>Industrial analysis:</b> Sampling procedures, sampling of bulk materials, techniques of sampling solids, liquids and gases, collecting and processing of data, particle size determination, rheological properties of liquids, plastics and their analysis.	10h
<b>VI</b>	<b>Modern instrumental methods of analysis:</b> pH and conductivity measurements with special reference to water and soil analysis, basic principles and applications of UV-visible spectroscopy, IR spectroscopy and non-dispersive IR, Raman spectroscopy, NMR Spectroscopy.	10h
<b>VII</b>	<b>Effluent treatment:</b> Principles and equipments for aerobic, anaerobic treatment like i) Anaerobic high-rate treatment of industrial wastewater and its reuse in industries; ii) UASB reactors; iii) EGSB reactors; iv) EGSB/IC reactors; and v) Industrial treatment examples. Adsorption, filtration, sedimentation, Bag filters, Electrostatic precipitator, Mist eliminator, Wet scrubbers, Absorbers, Suspended solids removal, Nitrification and denitrification. Phosphorus reduction.	08h

**Suggested Readings:**

1. Instrument Technology: Measurement of pressure, level, flow and temperature by E. B. Jones, Butterworth & Co (Publishers) Ltd.
2. Analytical Chemistry by Gary D Christian, Purnendu K Dasgupta, Kelvin A Schug, John Wiley & Sons.
3. Fundamentals of Analytical Chemistry by D A Skoog, D M West, F J Holler, S R Crouch, Publisher: Mary Finch.
4. A Primer for sampling solids, liquids and gases: based on the seven sampling errors of Pierre Gy by Pateicia L.Smith, Publisher: Society of Industrial and Applied Mathematics; American Statistical Association.
5. Wastewater Engineering (2013) by Metcalf and Eddy; Publisher - McGraw-Hill
6. Environmental Engineering (2015) by Peavy, Rowe and Tchobanoglous; Publisher - McGraw-Hill
7. Water Quality Engineering: Physical / Chemical Treatment Processes (2013) by Lawler and Benjamin; Publisher - John Wiley & Sons
8. Industrial Wastewater Treatment, Recycling and Reuse (2014) by Bhandari and Ranade; Publisher - Elsevier
9. Unit Operations and Processes in Environmental Engineering (1996) by Reynolds and Richards Publisher - CL Engineering

This course can be opted as an elective by the students of following subjects: Open for all

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Suggested Continuous Evaluation Methods:

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Course prerequisites: To study this course, a student must have had the subject .....in class/12<sup>th</sup>/ certificate/diploma.

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Suggested equivalent online courses:

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Further Suggestions:

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At the End of the whole syllabus any remarks/ suggestions:

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**Semester-III**  
**Paper-1 (Practical)**

**Course Title: Process Instrumentation and Industrial chemical analysis**

Programme: <p style="text-align: center;"><b>Diploma in Industrial instrumentation and chemical analysis</b></p>	Year: Second	Semester: Third
Paper-1 Practical		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 202F	Course Title: <b>Instrumentation and Industrial chemical analysis</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Instrumental methods of analysis by , Material testing, Water analysis, Use of transducers for measuring flow control and Flow measuring devices- floats.		
Credits: 2		<b>Core: Compulsory</b>
Max. Marks: 25+75		Min. Passing Marks:
<b>Total No. of Lectures: 60h</b>		
<b>Unit</b>	<b>Topics</b>	<b>No. of Lectures</b>
<b>I</b>	<b>Instrumental methods of analysis:</b> Use of colorimeter, flame photometer, pH meter, potentiometer, conductometer.	10h
<b>II</b>	<b>Material testing:</b> Testing of plastics/rubber, Young's modulus, optical, thermal, mechanical and electrical properties.	10h
<b>III</b>	<b>Water analysis:</b> Solid content, hardness, COD and other tests as per industrial specifications.	10h
<b>IV</b>	<b>Industrial analysis</b> – Analysis of common raw materials as per the industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.	20h
<b>V</b>	Use of transducers for measuring flow control and Flow measuring devices- floats.	10h
<b>Suggested Readings:</b>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-IV**  
**Paper-1 (Theory)**  
**Course Title: Process Chemistry**

Programme: <b>Diploma in Industrial instrumentation and chemical analysis</b>		Year: Second	Semester: Fourth
Paper-2 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 203F	Course Title: <b>Process Chemistry</b>		
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Nitration, Halogenation, Sulphonation, Oxidation, Hydrogenations, Alkylation, Esterification and Hydrolysis, Amination.			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0 or 3-1-0 Etc.			
Unit	Topics		No. of Lectures
I	<b>Nitration:</b> Introduction, nitrating agents, mechanism and nitration of paraffin hydrocarbons - benzene to nitrobenzene and m-dinitrobenzene, chlorobenzene to <i>o</i> - & <i>p</i> -nitrochlorobenzenes. Acetanilide to <i>p</i> -nitro acetanilide and toluene.		08h
II	<b>Halogenation:</b> Introduction, reagents for halogenations, halogenations of aromatics side chain and nuclear halogenations, commercial manufacture of chlorobenzene, chloral, monochloroacetic acid and chloromethanes.		08h
III	<b>Sulphonation:</b> Introduction, sulphonating agents, chemical and physical factors in sulphonation, mechanism of sulphonation, commercial sulphonation of benzene, naphthalene, alkyl benzene,		08h
IV	<b>Oxidation:</b> Introduction, types of oxidation reactions, oxidizing agents, mechanism of oxidation of naphthalene, phthalamide and anthracene, liquid phase oxidation and vapour phase oxidation, commercial manufacture of benzoic acid, maleic anhydride, phthalic anhydride, acetaldehyde, acetic acid		08h
V	<b>Hydrogenations:</b> Introduction, thermodynamics of hydrogenation reactions, catalysts for hydrogenation reactions, hydrogenation of vegetable oils, manufacture of methanol from carbon monoxide and hydrogen, catalytic reforming.		06h
VI	<b>Alkylation:</b> Introduction, types of alkylation, alkylating agents, thermodynamics and mechanism of alkylation reactions, manufacture of phenyl ethyl alcohol and alkyl benzenes (for detergent manufacture).		06h
VII	<b>Esterification and Hydrolysis:</b> Introduction, esterification reactions by organic acids, commercial manufacture of ethyl acetate, vinyl acetate, cellulose acetate. Introduction, hydrolyzing agents, mechanism of hydrolysis.		08h



<b>Suggested Readings:</b>		
<ol style="list-style-type: none"> <li>1. Organic Chemistry by Morrison Boyd, Pearson Publication.</li> <li>2. Advance Organic Chemistry by Bahl &amp; Bahl, S.Chand &amp; Company Ltd. New Delhi.</li> <li>3. Unit Process in Organic Synthesis, P. H. Groggins.</li> <li>4. Srivastava Alok Kumar, "Organic Chemistry-II", Mahaveer Publication, Dibrugarh, Assam, India.2021</li> </ol>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-IV**  
**Paper-1 (Practical)**

Course Title: **Qualitative and Synthetic methods**

Programme: <p style="text-align: center;"><b>Diploma in Industrial instrumentation and chemical analysis</b></p>	Year: Second	Semester: Third
Paper-1 Practical		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 204F	Course Title: <b>Qualitative and Synthetic methods</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Determination of flash point, ignition point of liquids and smoke point of a fuel, Chemical process of Nitration, sulphonation, friedel crafts reaction, esterification, hydrolysis, oxidation, halogenations, chlorosulphonation, reduction and amination, Synthesis of common industrial compounds such as 4-Bromo aniline, 3-Nitroaniline, Sulphanilamide, 4-Amino benzoic acid, 4-Nitro benzoic acid, Dihalobenzenes, Nitrohalobenzenes, Limit tests for chlorine, arsenic and heavy metals – Pb, As, Hg, Fe and ash content.		
Credits: 2	<b>Core: Compulsory</b>	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures: 60h		
<b>Unit</b>	<b>Topics</b>	<b>No. of Lectures</b>
<b>I</b>	Determination of flash point, ignition point of liquids and smoke point of a fuel.	05h
<b>II</b>	<b>Chemical process</b> – One or two examples of each of the following unit processes. Nitration, sulphonation, friedel crafts reaction, esterification, hydrolysis, oxidation, halogenations, chlorosulphonation, reduction and amination.	20h
<b>III</b>	<b>Synthesis of common industrial compounds:</b> Each step reaction monitor by TLC. 4-Bromo aniline, 3-Nitroaniline, Sulphanilamide, 4-Amino benzoic acid, 4-Nitro benzoic acid, Dihalobenzenes, Nitrohalobenzenes.	20h
<b>IV</b>	Limit tests for chlorine, arsenic and heavy metals – Pb, As, Hg, Fe and ash content.	15h
<b>Suggested Readings:</b>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-V**  
**Paper-1 (Theory)**  
**Course Title: Industrial Chemicals**

Programme: <b>Degree in Industrial Chemistry</b>		Year: Third	Semester: Fifth
Paper-2 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 301F	Course Title: <b>Industrial Chemicals</b>		
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Industrial Gases, Petroleum Refining Process, Carbon based Chemicals and Industrial catalysts, Pesticides and Fertilizers, Pulp and Paper industry, Surfactants, Soaps, Detergents and Cosmetics, Cane sugar industry, Manufacture of heavy organic chemicals, heavy inorganic chemicals, fine chemicals.			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures: 60h			
Unit	Topics		No. of Lectures
I	<b>Industrial Gases:</b> Manufacture, uses and economics of N <sub>2</sub> , O <sub>2</sub> , H <sub>2</sub> , CO <sub>2</sub> .		03h
II	<b>Petroleum Refining Process:</b> Introduction, distillation, octane number, additives, hydrotreating, cracking, reforming, alkylation and polymerization, separation of natural gas (methane production).		05h
III	<b>Carbon based Chemicals and Industrial catalysts:</b> Manufacture, properties and uses of methanol, formaldehyde, acetic acid, chlorofluoro carbons and fluorocarbons. Industrial catalysts like raney nickel, other forms of nickel, palladium and supported palladium, copper chromate, vanadium and platinum based catalyst. Aluminium alkoxides, titanium tetrachloride and titanium dioxide.		08h
IV	<b>Pesticides and Fertilizers:</b> (i) Manufacture and uses of insecticides (DDT, organophosphorus insecticides); herbicides (heterocyclic nitrogen herbicides) and biopesticides. (ii) Types of fertilizer [direct application fertilizers, mixed fertilizers (nitrogen, phosphorus and potassium sources, ammoniation), controlled release fertilizers and biofertilizers], liquid vs solid fertilizers.		09h
V	<b>Pulp and Paper industry</b> Manufacture of pulp and paper and their uses.		05h
	<b>Cane sugar industry:</b> Manufacture of white crystalline sugar, extraction of the juice, clarification (lime defaction process, by sulphate ion and by carbonation), evaporation, crystallization and refining of sugar, uses of bagasse.		
VI	<b>Manufacture of chemicals</b> with respect to- 1. Raw material, 2. Production process		07h

	<p>3. Quality Control, 4. Hazards and safety, 5. Effluent management.</p> <p><b>A. Heavy Organic Chemicals:</b> Fischer-tropsch synthesis, Applications and uses of zeolites as catalyst. Propyl alcohol, 1,4-butanediol, vinyl chloride, pyridines, picolines, phthalic anhydrides, glycerol, sorbitol, chloroform, ethanolamine.</p> <p><b>B. Heavy Inorganic Chemicals:</b> Ammonium phosphates, carbon blacks, manufacture of graphite and carbon, calcium carbide, silicon carbide, sodium thiosulphate, borax and boric acid.</p> <p><b>C. Fine Chemicals:</b> Sodium borohydrate, lithium aluminium hydride, sodium ethoxide, paracetamol, indigo, vat dyes. Essential oils, surfactants and emulsifying agents, coloring agents- manufacture of some natural and synthetic colors. Flavouring agents – fragrance and food additives. Biochemical reagents – ninhydrin, tetrazolium blue, 1,2-naphthaquinone-4-sulphonate.</p>	
<p><b>Suggested Readings:</b></p> <ol style="list-style-type: none"> <li>1. Industrial Chemistry, B. K. Sharma, GOEL Publishing House, 2000.</li> <li>2. Fundamentals of Petroleum Refining, 1<sup>st</sup> edition, M. Fahim, T. Al-Sahhaf, A. Elkilani, Elsevier Science.</li> <li>3. Pesticide Calcer Publication, P. B. Pandey.</li> <li>4. Principle Industrial Chemistry, C. A. Clausion, G. Mattson, Johnwly Sons New York.</li> <li>5. Unit Operators of Chemical Engineering, W. L. Mc. Cabe, J. C. Smith &amp; Parriet Mc. Graw Hill Book Company Singapore.</li> <li>6. Heat Transfer, A. F. Mills.</li> </ol>		
<p>This course can be opted as an elective by the students of following subjects: Open for all .....</p>		
<p>Suggested Continuous Evaluation Methods: .....</p>		
<p>Course prerequisites: To study this course, a student must have had the subject .....in class/12<sup>th</sup>/ certificate/diploma. .....</p>		
<p>Suggested equivalent online courses: .....</p>		
<p>Further Suggestions: .....</p>		

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-V**  
**Paper-2 (Theory)**

**Course Title: Pollution, its management and industrial economics**

Programme: <b>Degree in Industrial Chemistry</b>		Year: Third	Semester: Fifth
Paper-2 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 302F	Course Title: <b>Pollution, its management and industrial economics</b>		
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Pollutants, their statutory limits and Air Pollution, Water Pollution, Pesticide Pollution, Solid & Gaseous wastes, Factors involved in project cost estimation, Capital formation, Methods of determining depreciation, Some aspects of marketing, pricing policy, profitability criteria, Entrepreneurship, Choice of technology and Quality control.			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures: 60 h			
Unit	Topics	No. of Lectures	
I	<b>Pollutants, their statutory limits and Air Pollution:</b> Definition and Classification of Pollutants, Primary and Secondary pollutants, pollution evaluation methods, sources and classification of air pollution, major air pollutants and their health impacts, phenomenon of Acid Rain, Photo Chemical Smog and Ozone depletion, Composition of Fly-Ash, Pollution Control Equipment/techniques.	05h	
II	<b>Water Pollution:</b> Types of Water Pollution, Organic and Inorganic pollutants, Point and Nonpoint sources of water pollution, Estimation of Chlorine in water, measurement of BOD & COD, Techniques for removal of waste from water.	05h	
III	<b>Pesticide Pollution:</b> Classification of Chemical Pesticides, examples of Organochlorines and Organophosphates, Persistent Organic Pollutants (POPs) and their half-lives, Environmental effects of pesticides; soil and water contamination and its impact, Bioaccumulation of Pesticides and Pesticide contamination in Food.	05h	
IV	<b>Solid &amp; Gaseous wastes:</b> Removal of solid contaminants of wastes- coagulation, sedimentation, flocculation, solid waste disposal, incineration, fuel pelletization, soil conditioning Adsorption, Catalytic/non catalytic conversion, recovery of important gases, CO <sub>2</sub> , SO <sub>2</sub> , NO etc. Electrostatic precipitation and bag filters.	09h	
V	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.	08h	
VI	Methods of determining depreciation, 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.	08h	
VII	Need, scope and characteristics of entrepreneurship, special schemes for technical entrepreneurs development (STED), exposure to demand based, resource based, service based. Import substitute and export promotion industries, criteria for principles of products selection and developments.	10h	

<b>Suggested Readings:</b>		
<ol style="list-style-type: none"> <li>1. Industrial Pollution and Environmental Management, Author: Trivedy, R.K. ; Raman, N.S., ISBN: 9788172333249</li> <li>2. Environmental and Pollution Science, Third Edition 2019; Edited by: Mark L. Brusseau, Ian L. Pepper and Charles P. Gerba.</li> <li>3. Pesticides: Evaluation of Environmental Pollution, Edited By Hamir S. Rathore, Leo M.L. Nollet; ISBN 9780367865191, CRC Press.</li> <li>4. Industrial Chemistry (including Chemical Engineering), B. K. Sharma, GOEL Publishing House, 2000.</li> <li>5. Project Estimating &amp; Cost Management, P. F. Rad, Berrett Kochler Publisher.</li> </ol>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-V**  
**Paper-1 (Practical)**  
**Course Title: Industrial chemicals and pollution management**

<b>Programme:</b> <b>Degree in Industrial Chemistry</b>	Year: Third	Semester: Fifth
Paper-1 Practical		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 303F	Course Title: <b>Industrial chemicals and pollution management</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Determination of Flash and Fire point, Determination of (i) acid value- gum, and resin, (ii) iodine number- linseed oil, castor oil (iii) saponification value - coconut oil, Synthesis of organic compound: Paracetamol, Aspirin, Oils of winter green and Urea formaldehyde resin, Analysis of common raw materials as per the industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, Gravimetric and volumetric estimations.		
Credits: 2	<b>Core: Compulsory</b>	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures: 60		
Unit	Topics	No. of Lectures
<b>I</b>	Determination of Flash and Fire point Determination of (i) acid value- gum, and resin, (ii) iodine number- linseed oil, castor oil (iii) saponification value - coconut oil.	10
<b>II</b>	<b>Synthesis of organic compound:</b> Each step reaction monitor by TLC. Paracetamol, Aspirin, Oils of winter green and Urea formaldehyde resin.	10
<b>III</b>	<b>Industrial analysis</b> – Analysis of common raw materials as per the industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.	20
<b>IV</b>	Gravimetric and volumetric estimations.	20
<b>Suggested Readings:</b> 1. Saxena Ruchi, Srivastava Alok Kumar, “Read & Do Practical Chemistry”, Kitab Mahal, New Delhi, India, 2016.		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:  
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**Polymers**  
**Semester-VI**  
**Paper-1 (Theory)**  
**Course Title: Synthetic polymer**

Programme: <b>Degree in Industrial Chemistry</b>		Year: Third	Semester: Six
Paper-2 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 305F	Course Title: <b>Synthetic polymer</b>		
Course outcomes: Students gain knowledge and skills related to this paper is as follows. The science of large molecules, Types & general classification of polymers, Molecular weight and molecular weight distribution, Polymer solutions, structure and morphology, Synthesis, chemistry, properties and applications of the following Thermosetting polymers, Synthesis, chemistry, properties and applications of the following Thermoplastics polymers, Synthesis, properties and applications of conducting polymers, light emitting polymers and biodegradable polymers.			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures: 60h			
Unit	Topics	No. of Lectures	
I	<b>The science of large molecules:</b> Brief history, general definitions, basic chemistry and nomenclature of polymers Brief history of macromolecular science, general characteristics of polymers in comparison with common organic compounds.	05h	
II	<b>Types &amp; general classification of polymers:</b> Natural and synthetic polymers, organic & inorganic polymers, thermoplastics & thermosetting polymers, homo, hetero and copolymers, necessity of copolymers and copolymerization, block and graft copolymers, conducting polymers, biopolymers. Addition, condensation, free radical, ionic (anionic and cationic) and coordination polymerization, kinetics and mechanism of addition, condensation and ionic polymerization reactions.	07h	
III	<b>Molecular weight and molecular weight distribution:</b> Number, weight & viscosity average molecular weights of polymers, methods of determining molecular weights, significance of molecular weight distribution.	05h	
IV	<b>Polymer solutions, structure and morphology:</b> Criteria of polymer solubility, solubility parameters, fractionation of polymers with special reference to gel permeation chromatography.	05h	
V	<b>Polymer structure and morphology:</b> A brief idea of microstructure of polymers based on chemical and geometrical structures, intermolecular forces and chemical bonding in polymers, linear, branched and crosslinked polymers, stereoregular polymers, crystallinity in polymers, effect of crystallinity on the properties of the polymers, factors affecting the crystallinity.	08h	
VI	<b>Synthesis, chemistry, properties and applications of the following Thermosetting polymers:</b> Unsaturated polyesters: Fibre reinforced plastics (FRP), Polyurethanes, Phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde, Polycarbonates, Alky resins and amino resins, Epoxy resins – grades and curing process and its importance with mechanism, Silicones.	08h	



	Elastomers – polyisoprene, polybutadiene and neoprene.	
<b>VII</b>	<b>Synthesis, chemistry, properties and applications of the following Thermoplastics polymers:</b> Polyethylene – HDP, LDP, LLDPE. Polyvinyl chloride, PTFE (Teflon). Polystyrene – SBR, ABS, SAN. Vinyl polymers – PVA, PVB. Polyacetals, Polyamides – nylon-6, nylon-66 Polyethers and Polyesters – terephthalates (PET). Cellulosic polymers. Acrylic Plastics- PMMA	11h
<b>VIII</b>	<b>Synthesis, properties and applications of following:</b> <b>1. Conducting polymers:</b> Polyacetylene (PAC), Polyaniline (PANI), Polythiophene (PTh) <b>2. Light emitting polymers:</b> Polyparaphenylene (PPP), Polyparaphenylenevinylene (PPPV), Polyfluorene (PF). <b>3. Biodegradable polymers:</b> Polyglycolic acid (PGA), Polyhydroxybutyrate (PHB), Polyhydroxybutyrate-co-valerate (PHBV)	11h
<b>Suggested Readings:</b> <ol style="list-style-type: none"> <li>1. Polymer Science by UR Gowariker, NV Vishwanathan and J. Shreedhar, New Age International Publishers, New Delhi.</li> <li>2. An Introduction to polymer science and Technology, by S.S.Das and N.B.Singh, New CG age Internal Publisher, New Delhi.</li> <li>3. Conducting Polymers, Fundamentals and Applications: A Practical Approach by Prasanna Chandrasekhar.</li> <li>4. Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications, Andreas Lendlein, Adam Sisson, Wiley-VCH.</li> <li>5. Handbook of Biodegradable Polymers, Abraham J. Domb, Joseph Kost, David Wiseman, CRC Press.</li> <li>6. Handbook of Biodegradable Polymers, C. Bastioli ,Publisher : Smithers Rapra Press</li> <li>7. Handbook of Thermoset Plastics, 4th Edition, Hanna Dodiuk, Elsevier.</li> <li>8. Textbook of polymer Science by F.W. Billmeyer, John Wiley &amp; Sons, New York.</li> </ol>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-VI**  
**Paper-2 (Theory)**  
**Course Title: Polymerization techniques and characterization**

Programme: <b>Degree in Industrial Chemistry</b>		Year: Third	Semester: Six
Paper-2 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 306F		Course Title: <b>Polymerization techniques and characterization</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Rheology and mechanical properties of polymers, Degradation of polymers, Polymerization techniques, Plastic Technology, Fiber Technology, Elastomer Technology, Additives and Compounding.			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures: 60h			
Unit	Topics	No. of Lectures	
I	<b>Rheology and mechanical properties of polymers:</b> Viscous flow, rubber elasticity, visco elasticity, glassy state and the glass transition temperature, (GTT) factors affecting glass transition temperature, optical, electrical and thermal properties of polymers.	08h	
II	<b>Degradation of polymers:</b> Degradation of polymers by thermal, oxidative, mechanical and chemical methods, random degradation and chain depolymerization.	07h	
III	<b>Polymerization techniques:</b> A general idea of bulk, solution, suspension, emulsion, polymerization processes.	07h	
IV	<b>Plastic Technology:</b> General concept of plastics; A brief idea of compression molding, injection molding, extrusion and blow molding techniques, thermoforming and foaming, casting, extrusion, fibre spinning, coating and calandering, vulcanization of elastomers, reinforcing (Fibre reinforced plastics - FRP).	10h	
V	<b>Fiber Technology:</b> General concept of fibers; A brief idea of textile and fabric properties, fibre spinning (wet, dry and melt spinning)	10h	
VI	<b>Elastomer Technology:</b> General concept of elastomers; Vulcanization of elastomers, and its chemistry.	08h	
VII	<b>Additives:</b> A general idea of fillers, plasticizers, antioxidants, colourants, fire retardants, thermal stabilizers.	07h	

<p><b>Suggested Readings:</b></p> <ol style="list-style-type: none"> <li>1. Polymer Science &amp; Technology, 2nd edition, Joel R. Fried.</li> <li>2. Polymer Chemistry, B. K. Sharma.</li> <li>3. Polymer Science &amp; Engineering, D. J. Williams Prentice Hall Inc.</li> <li>4. Plastics Material, A. Brydson, Vth Edition, Butter Worth Heinemonn.</li> <li>5. Principle of Polymerization, Godian IInd edition, John Wielely &amp; Sons.</li> </ol>
<p>This course can be opted as an elective by the students of following subjects: Open for all          .....</p>
<p>Suggested Continuous Evaluation Methods:          .....</p>
<p>Course prerequisites: To study this course, a student must have had the subject .....in class/12<sup>th</sup>/          certificate/diploma.          .....</p>
<p>Suggested equivalent online courses:          .....</p>
<p>Further Suggestions:          .....</p>

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-VI**  
**Paper-1 (Practical)**  
**Course Title: Synthesis and analysis of polymers**

<b>Programme:</b> <b>Degree in Industrial Chemistry</b>	Year: Third	Semester: Six
Paper-1 Practical		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 307F	Course Title: <b>Synthesis and analysis of polymers</b>	
<p>Course outcomes:          Students gain knowledge and skills related to this paper is as follows.          Preparation of representative polymers, Determination of (i) saponification value - polyester (ii) Viscosity PMMA (iii) Hydroxyl value of a resin, Determination of (i) saponification value - polyester (ii) Viscosity PMMA (iii) Hydroxyl value of a resin, Degradation kinetics of polymers, polystyrene and PMMA, Determination of <math>T_g</math> value of phosphate glasses</p>		
Credits: 2	<b>Core: Compulsory</b>	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures: 60h		
Unit	Topics	No. of Lectures
<b>I</b>	Preparation of representative polymers: Bulk polymerization, polystyrene, PMMA Nylon and Polysulphiderubber Solution polymerization: Phenol formaldehyde, urea formaldehyde	10h
<b>II</b>	Determination of (i) saponification value - polyester (ii) Viscosity PMMA (iii) Hydroxyl value of a resin	10h
<b>III</b>	Material testing: Testing of plastics/rubber, Young's modulus, optical, thermal, mechanical and electrical properties.	15h
<b>IV</b>	Determination of molecular weights of the polymers by viscosity measurements. Determination of number average molecular weights of certain polymers such as polyphosphates and copolyphosphates by end group analysis method (pH. Titration)	15h
<b>V</b>	Degradation kinetics of polymers, polystyrene and PMMA, Determination of $T_g$ value of phosphate glasses	10h
<b>Suggested Readings:</b>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		

Further Suggestions:

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At the End of the whole syllabus any remarks/ suggestions:

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## Pharmaceuticals

Semester-VI

Paper-1 (Theory)

Course Title: **Pharmaceutical and Phytochemicals**

Programme: <b>Degree in Industrial Chemistry</b>		Year: Third	Semester: Six
Paper-2 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 309F	Course Title: <b>Pharmaceutical and Phytochemicals</b>		
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Pharmaceutical industry and Pharmacopoeias, Various types of pharmaceutical excipients, Evaluation of crude drugs, Surgical dressing, sutures, ligatures, Phytochemicals, Chemical constitution of plants, Various isolation procedures for active ingredients, Pharmaceutical quality control and packaging materials			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures: 60h			
Unit	Topics	No. of Lectures	
I	<b>Pharmaceutical industry and Pharmacopoeias:</b> Historical background and development of pharmaceutical industry in India in brief. Development of Indian Pharmacopoeia and introduction to B.P., U.S.P., E.P., N.F. and other important pharmacopoeias. Introduction to various types of formulations and routes of administration. Aseptic conditions, need for sterilization, various methods of sterilization.	06h	
II	<b>Various types of pharmaceutical excipients</b> – 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.	06h	
III	<b>Evaluation of crude drugs</b> – moisture contents, extractive value, volatile oil content, foreign organic matter. Quantitative microscopic exercises including of starch, leaf content (palisade ratio, stomatal number and index vein islet number and vein termination number) and crude fiber content. Various isolation procedures for active ingredients.	10h	
IV	<b>Surgical dressing, sutures, ligatures-</b> with respect to the process, equipments used for manufacture, methods of sterlization and quality control.	06h	
V	<b>Phytochemicals:</b> Introduction to plant classification and crude drugs, cultivation, collection, preparation for the market and storage of medicinal plants.	08h	
VI	<b>Chemical constitution of plants:</b> including carbohydrates, amino acids, proteins, fats, waxes, volatile oils, terpenoids, steriods, saponins, flavonoids, tannins, glycosides, alkaloids.	08h	

<b>VII</b>	<b>Various isolation procedures for active ingredients:</b> With example for alkaloid, e.g., vincaalkaloids, reserpine; one for steriods- sapogenin, diosgenin, diagroh.	08h
<p><b>Suggested Readings:</b></p> <ol style="list-style-type: none"> <li>1. An Introduction to Medicinal Chemistry by Graham L. Patrick.</li> <li>2. Textbook of Organic Medicinal and Pharmaceutical Chemistry by Charles O. Wilson, Ole Gisvold &amp; Robert F. Doerge.</li> <li>3. Principles of Medicinal Chemistry by William O. Foye, Thomas L. Lemice and David A. Williams.</li> </ol>		
<p>This course can be opted as an elective by the students of following subjects: Open for all .....</p>		
<p>Suggested Continuous Evaluation Methods: .....</p>		
<p>Course prerequisites: To study this course, a student must have had the subject .....in class/12<sup>th</sup>/ certificate/diploma. .....</p>		
<p>Suggested equivalent online courses: .....</p>		
<p>Further Suggestions: .....</p>		

At the End of the whole syllabus any remarks/ suggestions:  
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**Semester-VI**  
**Paper-2 (Theory)**  
**Course Title: Drugs and its manufacturing**

Programme: <b>Degree in Industrial Chemistry</b>	Year: Third	Semester: Six
Paper-2 Theory		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 310F	Course Title: <b>Drugs and its manufacturing</b>	
<p>Course outcomes: Students gain knowledge and skills related to this paper is as follows. Pharmacology, classification, general principles of processes related to drugs, their raw materials and enzyme systems.</p>		
Credits: 4		Core: Compulsory
Max. Marks: 25+75		Min. Passing Marks:

Total No. of Lectures: 60h		
Unit	Topics	No. of Lectures
I	<b>Pharmacology Drugs classification:</b> Pharmacology classification and Therapeutic classification with example. History of the CSA, DEA and FDA. Drugs & Cosmetics Act. Schedule of drugs 1 to 5. Concept of Drug Master File (DMF), Infringing and non-infringing process concept. Introduction of patent and its filing process in brief.	16h
II	General principle of fermentation processes and product processing. Brief idea of micro-organisms, their structure, growth and usefulness, enzyme systems useful for transformation microbial products.	10h
III	<b>Raw materials, process of manufacture, effluent handling etc., of the following bulk drugs</b> (i) Sulpha drugs- Sulphaguadine, Sulphamethoxazole (ii) Antimicrobial- Chloramphenicol, Furazolidine, Mercurochrome, Isoniazid, Na- PAS (iii) Analgesic- anti inflammatory- Salicylic acid and its derivatives, Ibuprofen, Mefenamic acid. (iv) Steroidal hormones- Progesterone, Testosterone, Methyl testosterone (v) Vitamins- Vitamin-A, Vitamin-B6, Vitamin-C. (vi) Barbiturates- Pentobarbital (vii) Blockers- Propranolol, Atenolol (viii) Cardiocascular agent- Methyl dopa (ix) Antihistamines- Chloropheneramine maleate. (x) Antibiotics drugs – Penicillin-G, semi synthetic penicillin, Rifamycin, Tetracycline, and Vitamin-B12. (xi) Antimalarial drugs. Anticancerous drugs. AntiAIDS vaccines.	20h
IV	<b>Biotransformation processes-</b> for Prednisolone, 11- Hydroxylation in steroids. Enzyme catalysed transformation, manufacture of Ephedrine.	07h
V	<b>Enzyme systems</b> - useful for transformation, microbial products, enzyme catalyzed transformation - manufacture of ephedrine.	07h
<b>Suggested Readings:</b> 1. Burgers Medicinal Chemistry and Drug Discovery by M.E. Wolff. 2. Watson David G., Pharmaceutical Chemistry, Elsevier-Health U.K. 3. Cairns Donald, Essential of Pharmaceutical Chemistry, Pharmaceutical press, London.		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:  
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**Semester-VI**  
**Paper-1 (Practical)**  
**Course Title: Pharmaceuticals**

Programme: <b>Degree in Industrial Chemistry</b>	Year: Third	Semester: Six
Paper-1 Practical		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 311F	Course Title: <b>Pharmaceuticals</b>	
<p>Course outcomes:  Students gain knowledge and skills related to this paper is as follows.  Demonstration of various pharmaceutical packaging materials, Limit tests for chlorine, heavy metals, arsenic, etc., of two representative bulk drugs, Active ingredient analysis of few types of formulations representing different methods of analysis- acidmetry, alkametry, nonaqueous complexometry, potentiometry, etc., Evaluation of crude drugs, Microbiological testing.</p>		
Credits: 2	<b>Core: Compulsory</b>	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures: 60h		
Unit	Topics	No. of Lectures
I	Demonstration of various pharmaceutical packaging materials, quality control tests of some materials- aluminium strips, cartons, glass bottles.	05h
II	<b>Limit tests</b> for chlorine, heavy metals, arsenic, etc., of two representative bulk drugs.	10h
III	<b>Active ingredient analysis</b> of few types of formulations representing different methods of analysis- acidmetry, alkametry, nonaqueous complexometry, potentiometry, etc.	15h
IV	<b>Evaluation of crude drugs</b> - microscopic examination- determination and identification of starch grannules, calcium oxalate.	15h
V	<b>Microbiological testing</b> - Determination of MIC of some antibacterial and antifungal drugs by zone/cup plate methods.	15h
<b>Suggested Readings:</b>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

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Effect of plant growth regulators on the development of plants and fruits. Industrial visits to agrochemical industry and submission of reports.

## Agrochemicals

### Semester-VI Paper-1 (Theory)

#### Course Title: General & Halogenated Insecticides

Programme: <b>Degree in Industrial Chemistry</b>		Year: Third	Semester: Six
Paper-1 Theory		Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 313F		Course Title: <b>General &amp; Halogenated Insecticides</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Types of pest and pesticides, Inorganic insecticides, Insecticides of plant origin, Organophosphorus insecticides, Organothiophosphorus insecticides, Carbamate insecticides, Chemical and Biofertilizers, Chlorinated hydrocarbons			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures: 60h			
Unit	Topics	No. of Lectures	
<b>I</b>	<b>Types of pest and pesticides:</b> Stomach poison, contact poisons systemic poisons, fumigants. Effect of pesticides on soil and environment.	07h	
<b>II</b>	<b>Inorganic insecticides:</b> Arsenic insecticides, Paris green, Fluoro insecticides.	04h	
<b>III</b>	<b>Insecticides of plant origin:</b> Nicotine, Nornicotine, Pyrethroids, Rotenoids, Anabasin, Aliethrin	04h	
<b>IV</b>	<b>Organophosphorus insecticides:</b> <b>Phosphoric acid derivatives-</b> Dimecron, dichlorovos, naled, phosphinon, etc. SAR in the class.	05h	
<b>V</b>	<b>Organothiophosphorus insecticides:</b> <b>Thiophosphoric acid derivatives-</b> Parathion, Methyl parathion, Thiophos, Demetron, Chlorthion, Paraoxon, etc. <b>Dithiophosphoric acid derivatives-</b> Melathion, Dimethoate, Thiocron, Formathion, Mecarbam, etc.	12h	
<b>VI</b>	<b>Carbamate insecticides:</b> Carbaryl, Isolan, Mesurol, Zactran, Demetram, Pyrolan, Baygon, mode of action.	08h	
<b>VII</b>	<b>Chlorinated hydrocarbons:</b> DDT, DDD, Nestrin, Dilan, Perthan, Dimite, Chlorobenzilate, Sulphenex, Ovotran, Aramite, DFDT, SAR in the class and mode of action, BHC, Chlodane, Heptachlor, Aldrin, Dieldrin, endrin, Faodrin, Endosulfan, SAR in the class and mode of action.	12h	

<b>Suggested Readings:</b> 1. Knowles, Alan (Ed.) “Chemistry and Technology of Agrochemical formulations” e book- <a href="https://www.springer.com/gp/book/9780751404432">https://www.springer.com/gp/book/9780751404432</a> 2. Jaga Praveen Kumar and Singh Bharat “ Soil fertility, Fertilizers and Agrochemicals, Daya Publishing House, 2016
This course can be opted as an elective by the students of following subjects: Open for all .....
Suggested Continuous Evaluation Methods: .....
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....
Suggested equivalent online courses: .....
Further Suggestions: .....

At the End of the whole syllabus any remarks/ suggestions:

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**Semester-VI**  
**Paper-2 (Theory)**  
**Course Title: Fungicides and Herbicides**

Programme: <b>Degree in Industrial Chemistry</b>	Year: Third	Semester: Six
Paper-2 Theory	Subject: <b>Industrial Chemistry</b>	
Course Code: ICH 314F	Course Title: <b>Fungicides and Herbicides</b>	
Course outcomes: Students gain knowledge and skills related to this paper is as follows. Fungicides, Organomercuric compounds, Dithiocarbamates, Miscellaneous fungicides, Herbicides, Fumigants, Rodenticides, Nematicides, Plant growth regulators, Formulation of pesticides		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures: 60h		
<b>Unit</b>	<b>Topics</b>	<b>No. of Lectures</b>

I	<b>Fungicides:</b> Introduction, Sulphur, lime sulphur, copper sulphate, bordeaux mixture, bordeaux paste, bordeaux paint, burgundy mixture, copper oxychloride, cuprous oxide, mercurous chloride.	08h
II	<b>Organomercuric compounds:</b> Ethyl mercuric chloride, ceresan-M, panagen, agalol, uspulan, puratized, germisan; mode of action, agrosan GN.	08h
III	<b>Dithiocarbamates:</b> Ziram, ferbam, thiram, nabam, zineb, maneb, captan, hinosan, vapam, etc. Mode of action.	06h
IV	<b>Miscellaneous fungicides:</b> Dithanon, diclone, captan, polpet, diflolan, mesulfan, brestan, dodine, glyodin, methyrimol, terrazole.	08h
V	<b>Herbicides:</b> Introducion: 2,4-D; 2,4-DB; 2,4-DES; MCPB; 2,4,5-I, Monujron, fenuron, TCA, paraquat.	06h
VI	<b>Fumigants:</b> HCN, CS <sub>2</sub> , ethylene halides, durofume, methyl halides. <b>Rodenticides:</b> Zice phosphide, warfarin <b>Nematicides:</b> DD mixture, aldicarb, fensulfothion	08h
VII	<b>Formulation of pesticides:</b> Dry formulations- Dusts, grannules, wettable powders, seed disinfectants, liquid formulations- emulsions, suspensions, etc., aerosols and sprays	08h
<b>Suggested Readings:</b>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:  
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**Semester-VI**  
**Paper-1 (Practical)**  
**Course Title: Analysis of Agrochemicals**

Programme: <b>Degree in Industrial Chemistry</b>	Year: Third	Semester: Six
Paper-1 Practical		Subject: <b>Industrial Chemistry</b>
Course Code: ICH 315F	Course Title: <b>Analysis of Agrochemicals</b>	

Course outcomes: Students gain knowledge and skills related to this paper is as follows. Isolation and estimation of active ingredients of commercially available insecticide formulations, Preparation of selected pesticide formulations 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, Isolation of nicotine from tobacco leaves/ wastes		
Credits: 2		<b>Core: Compulsory</b>
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures: 60h		
Unit	Topics	No. of Lectures
I	Isolation and estimation of active ingredients of commercially available insecticide formulations.	12h
II	Preparation of selected pesticide formulations in the form of dusts, emulsions, sprays.	12h
III	Estimation of pesticide residues in food articles.	12h
IV	Study of the degradation of pesticides in soil in the presence of sunlight and moisture. Determination of pesticide contents in the soil.	12h
V	Isolation of nicotine from tobacco leaves/ wastes	12h
<b>Suggested Readings:</b>		
This course can be opted as an elective by the students of following subjects: Open for all .....		
Suggested Continuous Evaluation Methods: .....		
Course prerequisites: To study this course, a student must have had the subject .....in class/12 <sup>th</sup> / certificate/diploma. .....		
Suggested equivalent online courses: .....		
Further Suggestions: .....		

At the End of the whole syllabus any remarks/ suggestions:

.....

Effect of plant growth regulators on the development of plants and fruits. Industrial visits to agrochemical industry and submission of reports.

**DEEN DAYAL UPADHYAYA GORAKHPUR UNIVERSITY**

**GORAKHPUR**



**B.Sc. INDUSTRIAL CHEMISTRY PROGRAMME**

**(B.Sc. IC 4<sup>th</sup> Year)**

**(B.Sc. IC Hons and B.Sc. IC Research Degree Syllabus)**

**Department of Chemistry**

**(w.e.f Academic Session 2024 onwards)**

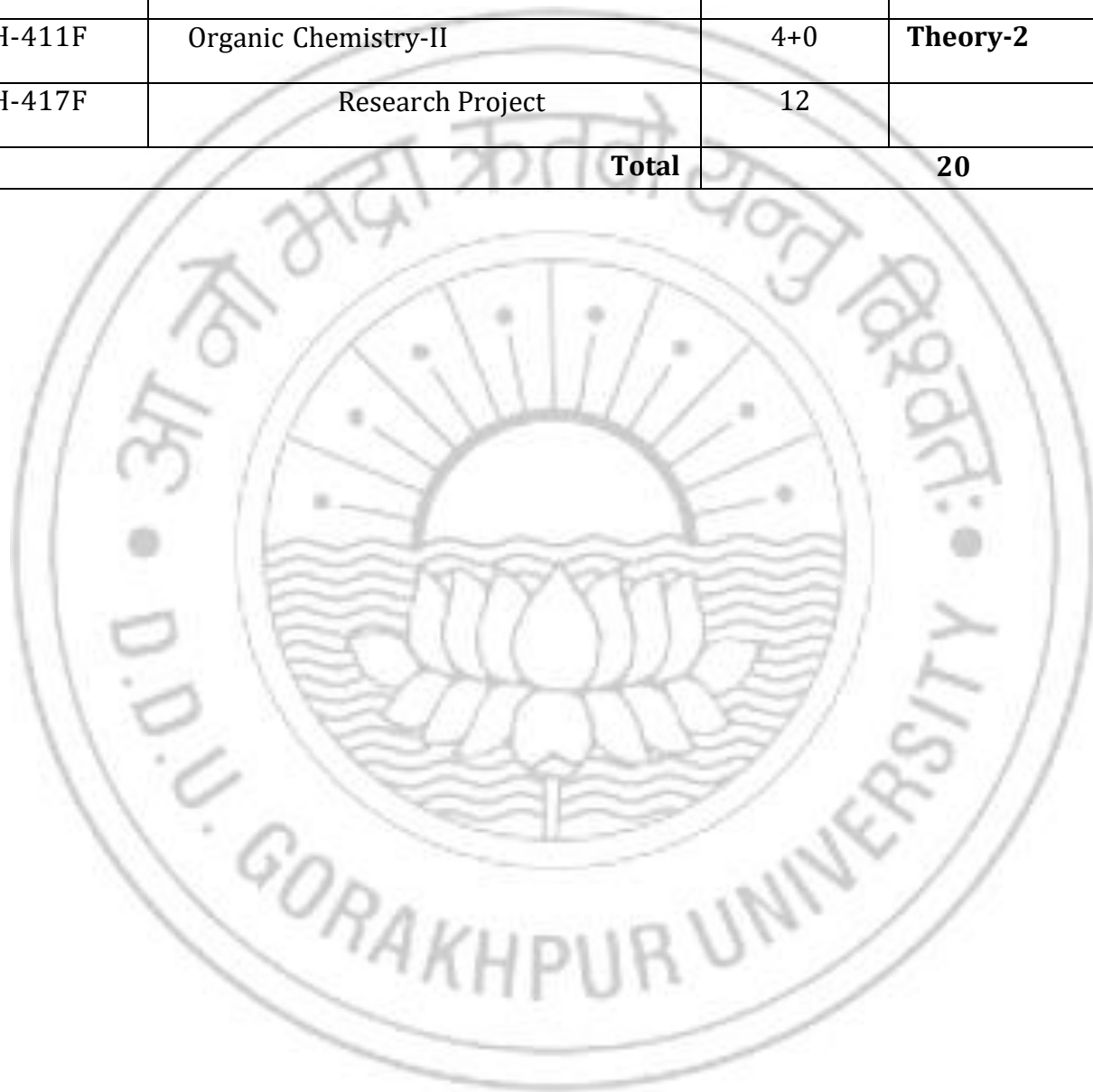
**SYLLABUS****B.Sc. Industrial Chemistry (IC) 4<sup>th</sup> Year (Honours and Research)**

<b>SEMESTER VII Hons and Research (4 theories+1 Practical) (common syllabus)</b>			
<b>Course Code</b>	<b>Course Name</b>	<b>Credit</b>	<b>Theory/Practical</b>
ICH-401F	Physical Chemistry	4+0	<b>Theory-1</b>
ICH-402F	Inorganic Chemistry-I	4+0	<b>Theory-2</b>
ICH-403F	Organic Chemistry-I	4+0	<b>Theory-3</b>
ICH-404F	Basics of Medicinal Chemistry	4+0	<b>Theory-4</b> (Choose any one)
ICH-405F	Introduction to Polymeric Materials	4+0	
ICH-406F	Quality Control and Industrial Hazards	4+0	
ICH-407F	Unit Operations and Process Utilities	4+0	
ICH-408F	Practical	0+4	<b>Practical</b>
<b>Total</b>		<b>20</b>	

**SEMESTER VIII Hons Course (4 theories+1 Practical)**

<b>Course Code</b>	<b>Courses</b>	<b>Credit</b>	<b>Theory/Practical</b>
ICH-409F	Analytical Chemistry-I	4+0	<b>Theory-1</b>
ICH-410F	Inorganic Chemistry-II	4+0	<b>Theory-2</b>
ICH-411F	Organic Chemistry-II	4+0	<b>Theory-3</b>
ICH-412F	Medicinal Chemistry-I	4+0	<b>Theory-4</b> (Choose any one)
ICH-413F	Polymer Science-I	4+0	
ICH-414F	Agrochemicals and Organic Fertilizers	4+0	
ICH-415F	Petrochemicals, Oils & Soaps	4+0	
ICH-416F	Practical	0+4	<b>Practical</b>
<b>Total</b>		<b>20</b>	

<b>SEMESTER VIII Hons (2 theories+1 research project)</b>			
<b>Course Code</b>	<b>Courses</b>	<b>Credit</b>	<b>Theory/Practical</b>
ICH-409F	Analytical Chemistry-I	4+0	<b>Theory-1</b>
ICH-411F	Organic Chemistry-II	4+0	<b>Theory-2</b>
ICH-417F	Research Project	12	
		<b>Total</b>	<b>20</b>



## **Semester-VII**

### **(B.Sc. IC-Hons and Research)**

### **ICH-401F: Physical Chemistry**

#### **Unit-1**

##### **Surface Chemistry and Interfacial Phenomenon**

Adsorption isotherm, estimation of surface area by BET method, surface films of liquids, Sols, Gels, Emulsions, Microemulsions, Micelles, (CMC); factors affecting CMC, counter ion binding to micelles, aerosols, effect of surfactants, Hydrotropes.

#### **Unit-2**

##### **Catalysis**

Introduction, types - homogeneous and heterogeneous, basic principles, mechanism, factor affecting the catalysis, introduction to phase transfer catalysis, Enzyme catalysis, Micelle catalyzed reaction - rate model, industrially important reactions.

#### **Unit-3**

##### **Electro Chemistry**

Standard electrode potential, galvanic series, galvanic cells, concentration cells, polarization,

Corrosion: classification of corrosion, corrosion reactions, factors affecting corrosion, protection from corrosion.

#### **Unit-4**

Electroplating: applications of electroplating, pickling, mechanical preparation of surfaces, cleaning, rinsing, electroplating equipment and operating conditions, characteristics of electroplating wastes, batteries.

##### **Recommended Text Books**

1. Electrochemistry by S. Glasstone
2. Electrochemistry by Potter
3. Modern Electrochemistry by Bockris Reddy Vol I&II
4. Comprehensive Physical Chemistry by N.B. Singh, S.S. Das and N.S. Gajbhiye, New Age International Publishers.



## ICH-402F: Inorganic Chemistry-I

### Unit-1

Shapes of molecules: VSEPR theory and hybridization; Coordination Chemistry: Crystal field theory, Jahn-Teller theorem, Spectrochemical series.

### Unit-2

Molecular orbital theory, Magnetic Properties, Nephelauxetic series, L-S & j-j coupling scheme, Terms and Microstates, Orgel and TS diagrams, Electronic spectra of metal complexes.

### Unit-3

Stability constants of metal complexes, Inorganic Reaction Mechanisms, Hydrolysis Reactions, Trans Effect, Electron Transfer Reactions, Carbonyls and Metallocenes.

### Unit-4

Bioinorganic Chemistry: Iron Sulfur Clusters, Porphyrins and Corrins, Metal-Nucleotide Complexes, Dioxygen Binding, Photosynthesis; Metallo-Enzymes: Model Compounds.

### Recommended Text Books

1. Inorganic Chemistry, 4th Edition, Principles of Structure and Reactivity by J.F. Huheey, E.A. Keiter and R.L. Keiter, 1993
2. Chemistry of Elements by N.N. Greenwood and A. Ernschaw, Butterworths, 1997
3. Mechanism of Inorganic Reactions; A Study Of Metal Complexes in Solution by F. Bosolo and R.G. Pearson
4. Organometallic Chemistry: A Unified Approach by R.C. Mehrotra and A.K. Singh

## ICH-403F: Organic Chemistry-I

### Unit-1

#### Reaction Mechanism

**Structure and Reactivity:** Type of mechanisms, type of reactions, thermodynamic and kinetic requirements, Curtin - Hammett Principal. Potential energy diagrams, transition states and intermediates, methods of determining mechanism.

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.

### Unit-2

Effect of structure and reactivity - resonance and field effects, quantitative treatment. The Hammett equation and linear free energy relationships substituents and reaction constants. Taft equation.

### Unit-3

#### Aliphatic Electrophilic Substitution

Bimolecular mechanism -  $SE^2$ ,  $SE^i$ . The  $SE^1$  mechanism, electrophilic substitution accompanied by double bond shift. Effect of substrate leaving group and the solvent polarity on the reactivity.

#### Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagram. Ipsoattack.

### Unit-4

#### Aliphatic Nucleophilic Substitution

The  $SN^2$ ,  $SN^1$ , mixed  $SN^1$  and  $SN^2$  mechanism. The neighbouring group participation of  $\pi$  and  $\sigma$  bond. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and regioselectivity.

#### Recommended Text Books

1. Advanced Organic Chemistry Part. A & B By F. A. Carey and R. J. Sundberg, Plenum Publisher, New York, 2007.
2. Advanced Organic Chemistry By J. March, 2007.
3. Organic chemistry By J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press, New York, 2001.

## ICH-404F: Basics of Medicinal Chemistry

### Unit-1

#### General Pharmacological Principles

- a) Routes of drug administration.
- b) **Pharmacokinetics:** Passive diffusion and filtration, specialized transport, absorption, bio-availability, distribution, bio transformation (metabolism), Excretion, clearance, plasma half life, loading and maintenance dose.
- c) **Pharmacodynamics:** Principles of drug action, mechanism of drug action, drug response relationship, drug dosage, factors modifying drug action.
- d) Adverse drug effects.

### Unit-2

#### Antipyretics analgesics

- a) **Some common antipyretic drug:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of paracetamol, acetanilide, aspirin, mefenamic acid
- b) **Opioid analgesic or Narcotic analgesic drugs:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Morphine sulphate, codeine, metazocine.
- c) **Non steroidal anti inflammatory drugs:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Ibuprofen, Auranofin.

### Unit-3

- a) **Sulphonamides:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Sulfanilamide, Sulfathiazole, Sulphadiazine, Sulfacetamide, Mafenide
- b) **Cotrimoxazole, Quinolones and Fluoroquinolones:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of cotrimoxazole, ciprofloxacin, norfloxacin.

#### Unit-4

**Anti Cancer Drugs:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Cyclophosphamide, Melphalan, Busulfan, Methotrexate.

#### Recommended Text Books

1. An Introduction to Medicinal Chemistry by Graham L. Patrick.
2. Textbook of Organic Medicinal and Pharmaceutical Chemistry by Charles O. Wilson, Ole Givold & Robert F. Doerge.
3. Principles of Medicinal Chemistry by William O. Foye, Thomas L. Lemice and David A. Williams.
4. Burgers Medicinal Chemistry and Drug Discovery by M.E. Wolff.



## **ICH-405F: Introduction to Polymeric Materials**

### **Unit-1**

Concept of polymers, polymerization, definition, classification and types, Bonding In polymers.

Condensation polymerization - types extent of condensation and degree of polymerization. Cross-linking, gel point and ring opening polymerization.

Addition polymerization free radical & Ionic chain transfer and inhibition. Co-ordination polymerization Ziegler copolymerisation - mechanism of copolymers block and graft copolymers. Kinetics of co-polymerisation.

### **Unit-2**

#### **Chemical properties**

Hydrolysis, acidolysis, aminolysis, hydrogenation, addition, substitution isomerisation, cyclization and cross linking reactions of polymer.

#### **Polymerization kinetics and Techniques**

Free radical, cationic, anionic and radiation, polycondensation, solution, emulsion and suspension polymerizations, Advantages and disadvantages of the techniques and of the products from them.

### **Unit-3**

#### **Molecular mass**

Relative molecular mass,  $m_w$ ,  $m_n$  and polydispersibility. colligative property measurement and group analysis. Light scattering, ultra centrifugation, osmotic pressure and viscosity methods of molecular mass measurement. Gel permeation chromatography.

### **Unit-4**

Glassy state, glass transition temperature, Mechanisms of glass transitions temperature, Factors influencing the glass transition temp, Relation of glass transitions temperature with molecular weight and melting point. Importance of glass transition temperature, crystallinity in polymers

#### **Recommended Text Books**

1. Text Books of Polymer Science : F.W. Billmayer Jr.
2. Physical Chemistry : P.W. Atkins (ELBS)

## ICH-406F: Quality Control and Industrial Hazards

### Unit 1

Statistical Quality Control Techniques: Statistical treatment of data. Control charts, Performance Evaluation uncertainties in measurement. Validation of analytical methods.

### Unit 2

Quality Assurance: Elements of quality Assurance, Quality Management System Quality management concepts and principles: ISO 9001:2000 QMS Case studies on ISO 9001: 2000 in chemical industries. ISO 14000 Series of Standards. TQM in Chemical Industry. Six Sigma Approach to Quality: Applying Six Sigma to chemical Industries. Accreditation of QC laboratories: Tools and Mechanisms ICH Guidelines on Drug substances and Products.

### Unit 3

**Industrial hazards and Safety:** Process hazards checklists, hazard surveys, safety program, Hazop safety reviews.

**Industrial pollution:** Classification of hazards chemicals, storage, transportation, handling, risk assessments, challenges/solutions.

### Unit 4

**Eco-friendly effluents disposal:** Water pollutants, health hazards, sampling and analysis of water, water treatment, different industrial and domestic effluents and their treatment and disposal, advanced waste water treatment, effluent quality standards and laws, chemical industries, tannery, dairy, textile effluents, common treatment.

### Recommended Text Books

1. Industrial Safety Management: Hazard Identification and Risk Control by L.M. Deshmukh.
2. Industrial Safety, Health & Environment Management Systems by R.K. Jain & S. S. Rao.

## ICH-407F: Unit Operations and Process Utilities

### Unit 1

**Distillation:** Basic Principles and Applications, Flash operation, Continuous distillation, Batch Distillation, McCabe Thiele method, Plate efficiency.

**Multi component Distillation:** Phase equilibrium with multi component distillation, flash distillation of multi component mixtures.

### Unit 2

**Leaching and Extraction:** Leaching, Principles of continuous countercurrent leaching, Liquid Extraction, principles of extraction.

**Gas Absorption:** Principle of Absorption, Rate of absorption, Design of Packed towers.

**Adsorption:** Adsorption equipment, Adsorption Isotherms, Principle of Adsorption, Design of equipments.

### Unit 3

**Evaporation:** Introduction and Basic principle, Equipments, Short tube (standard) Evaporator, Forced circulation evaporators, Falling film evaporators, Climbing film (upward flow) evaporators, Wiped (agitated) film evaporator.

**Drying:** Introduction, Free moisture, Bound moisture. Drying curve, Drying equipments.

**Crystallization:** Introduction, Solubility, Super saturation, Nucleation, Crystal growth, Crystallization Equipments.

### Unit 4

#### Process Utilities in Chemical industries

**Water:** Specification of Industrial use, Various Water Treatment methods.

**Air:** Specification of Industrial use, Processing of air.

**Steam:** Generation and Industrial Use.

**Boilers:** Types of boilers and their functioning.

#### Recommended Text Books

1. McCabe, W.L., Smith, Julian C. & Harriett, Peter, "Unit Operations of Chemical Engineering", McGraw Hill, New Delhi, 7/e, 2005.
2. Geankoplis, Christie J., "Transport Processes and Unit Operations", Prentice Hall of India, New Delhi, 3/e, 1997
3. Max S. Peters, Klaus D. Timmerhaus and Ronal E. West, Plant Design and Economics for Chemical Engineers, McGraw-Hill, New York.

**Semester-VII**  
**(B.Sc. IC-Hons and Research)**

**ICH-408F: Practical**

**Marks (Practical): 100; Time: 8 h in two days;**

**Marks distribution (Practical)**

**Practical: 75 marks**

**Internal Assessment: 25 marks**

**Experiments**

1. Analysis of primary binary organic mixture (Liquid-Liquid, Liquid-Solid, Solid-Solid)
2. Determination of equivalent weight of organic acids by direct titration method
3. To determine the strength of given solution of NaOH with N/10 oxalic acid.
4. Spot test for the detection of inorganic ions (any ten cations)
5. Determination of heavy metals in industrial waste water
6. Determine the degree of hydrolysis and hydrolysis constant of  $\text{CH}_3\text{COONa}$ .
7. To determine the adsorption isotherm of acetic acid by activated charcoal.
8. To determine surface tension of given liquid by stalagmometer.
9. To determine the moisture content of a given sample by oven heating method.
10. Preparation of rose water by simple distillation.
11. Preparation of urea formaldehyde resin.
12. Preparation of phenol formaldehyde resin.
13. Estimation of sulphur in organic compounds
14. Batch sedimentation test.
15. Solid-Liquid Extraction of oil from oil seeds
16. Rate of dehydration of vegetable products.
17. Extraction of essential oil
18. Solid-liquid extraction
19. Liquid-liquid extraction
20. To determine the relative viscosity of given liquid with respect to water by Ostwald's viscometer.



## Semester-VIII

### (B.Sc. IC-Hons)

#### ICH-409F: Analytical Chemistry-I

##### Unit-1

###### Data Analysis

Types of errors, propagation of errors, accuracy and precision, significant figures, leastsquare analysis, average, standard deviation, t-test, standardization of analytical methods.

##### Unit-2

###### Titrimetric Methods of Analysis

General concept, stoichiometric calculations, acid-base titrations, titration curves, acid-base indicators, complexometric titration, metal ion indicator, precipitation titrations, adsorption indicators.

##### Unit-3

###### Gravimetric Methods of Analysis

Principles of gravimetric analysis, formation and properties of precipitates, applications of gravimetric analysis, organic precipitation.

##### Unit-4

###### Solvent Extraction

Theoretical principle, classification, factors favouring extraction, extraction equilibrium, Instrumentation and application.

##### Recommended Text Books

1. Fundamentals of Analytical Chemistry: D.A. Skoog, D.M. West and F.J. Holler, 1992, 6e
2. Quantitative Inorganic Analysis, A.I. Vogel, 2012, 7e
3. Instrumental Methods of Chemical Analysis: B.K. Sharma, 2011
4. Instrumental Methods of Chemical Analysis: H. Kaur, 2016, 12 e
5. Analytical Chemistry, Gary D. Christian, 2007, 6e
6. Instrumental Methods of Analysis: H.H. Willard, L.L. Merrit, Jr. J.A. Dean, 1974, 5e

## **ICH-410F: Inorganic Chemistry-II**

### **Unit-1**

Organometallic chemistry and catalysis in industry: Industrial applications of organotransition metal compounds; Important catalytic reactions: Hydrogenation, Wacker process, Ziegler-Natta catalysis;

### **Unit-2**

Metal carbonyls compounds; Organometallic reagents in organic synthesis: Principle, preparation and applications of Li, Mg, Hg, Zn, Ni, Pd, Fe, Co and boron compounds in organic synthesis; Medicinal application of organometallic chemistry.

### **Unit-3**

Synthetic methods for inorganic materials such as dry and wet method, sol-gel method.

### **Unit-4**

#### **Metals & Metallurgy**

Basic concept and process involved e.g. iron, aluminium, copper, nickel

#### **Recommended Text Books**

1. Comprehensive Organometallic Chemistry, Ed. E.W. Abel, F.G.A. Stone and G. Wilkinson, Pergamon, 1982.
2. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, Wiley, 1999.
3. The chemistry of elements, N.N. Greenwood and A. Earnshaw, 1997.
4. Inorganic Chemistry, principles of structure and reactivity. J.E. Huheey, Harper, 1983.
5. Organometallic Chemistry (A unified approach), R.C. Mehrotra and A. Singh, Wiley Eastern, 1991.
6. Industrial Chemistry by B.K. Sharma.
7. Industrial Chemistry by P.C. Jain and Monika Jain.

## ICH-411F: Organic Chemistry-II

### Unit-1

#### Addition to carbon - carbon multiple bond

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals.

Hydrogenation of double and triple bonds, Hydrogenation of aromatic rings, Hydroboration.

#### Addition to Carbon - Hetero Multiple bond

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl compounds, Wittig reaction.

### Unit-2

#### Elimination Reactions

The E2, E1 and E<sub>1</sub>CB mechanism and their spectrum. Orientation of the double bond. Mechanism and orientation in Pyrolytic elimination.

### Unit 3

Stereochemistry: Stereoselectivity, stereospecificity, conformational, optical isomerism, optical activity, classification of chiral molecules based on symmetry, molecular symmetry and asymmetry, geometrical isomerism.

### Unit 4

Asymmetric synthesis. Retrosynthetic analysis. Application of symmetry in photochemistry and photochemical and pericyclic reactions.

#### Recommended Text Books

1. Stereochemistry of carbon compounds by E. L. Eliel, 1997.
2. Stereochemistry by P. S. Kalsi, 1997.
3. Stereochemistry of Organic compounds By D. Nasipuri, 1994.

## ICH-412F: Medicinal Chemistry-I

### Unit-1

#### Antibiotics

**a)  $\beta$ -Lactam antibiotics:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Penicilline (Benzyl penicilline, cloxacillin, ampicilline) and Cephalosporins (cephalexin).

**b) Aminoglycosides Antibiotics:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Streptomycin, neomycin.

### Unit-2

**a) Tetracyclines and chloramphenicol:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Tetracycline, Minocycline and Chloramphenicol.

**b) Macrolide Antibiotics:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Erythromycin.

### Unit-3

**a) Antitubercular Drugs:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Isoniazid, Rifampin, Streptomycin.

**b) Antimalarial Drugs:** Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Chloroquine, Primaquine Phosphate.

### Unit-4

Drugs acting on gastrointestinal disorders

(a) Agents for control of gastric acidity and treatment of peptic ulcers:

Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Ranitidine, Sucralfate.

(b) Emetics, Antiemetics and other Gastrointestinal drugs.

(c) Drugs for constipation and Diarrhoeas: Classification, pharmacology, mode of action, adverse effects, synthesis and structure activity relationship of Bran, Ispaghula, Diphenylmethanes, Sulfasalazine, Codeine.

#### Recommended Text Books

Medicinal Chemistry by A. Burger, 2002

## ICH-413F: Polymer Science-I

### Unit-1

**Polymer Rheology and Morphology:** Introduction stress and strain, ideal elastic solid, Newtonian and non-newtonian fluid. Apparent viscosity the power, low molecular hole concept, weissenberg effects, rheological properties of fluid, melt fracture and irregular, time dependent flow, viscoelastic behaviour, mechanical model of a viscoelastic material relaxation enhancement under constant stress. Hysteresis, creep and relaxation of typical plastics.

### Unit-2

**Physical & mechanical testing of Polymer:** Stress-strain measurement, dynamic mechanical behaviour, stress cracking, hardness, tear strength or tear resistance, resilience's, flex cracking resistance, abrasion resistance, impact resistance.

### Unit-3

#### Rubber

Materials and Processing Technology

Introduction, types, thermoplastic elastomers (TPE), compounding and processing technology, vulcanization of elastomers, theory and accelerator action of sulphur vulcanization, non-sulphur vulcanization, ebonite latex technology some major rubber products. Polymer industries in India.

#### Polymer degradation and stabilizers

Thermal degradation, photo degradation, Oxidative, degradation biological degradation, the role of antioxidants and stabilizers.

### Unit-4

#### Plastics Materials

Introduction, Synthesis, properties and uses of following:

1. Polyethylene
2. Polystyrene
3. Acrylic fibers
4. Polyamides
5. Polycarbonates
6. Cellulose plastics
7. Silicones
8. Poly Vinyl Chloride
9. Polyurethane's

### Recommended Text Books

1. F. W. Billmeyer, "Textbook of Polymer Science", John Wiley & Sons, New York.
2. H. R. Allcock, F. W. Lampe and J. E Mark, "Contemporary Polymer Chemistry", Pearson Education Prentice Hall, Singapore.
3. Charles E. Cariaher, "Polymer Chemistry: An Introduction", Marcel Dekker Inc, New York.
4. U. R. Gowariker, N. V. Vishwanathan and J. Shreedhar, "Polymer Science", New Age International Publishers, New Delhi.
5. S. S. Das and N. B. Singh, "An Introduction to Polymer Science and Technology", New age International Publishers, New Delhi.



## ICH-414F: Agrochemicals and Organic Fertilisers

### Unit-1

Classification of Pesticides, structure, synthesis, mode of action, application and environmental impact of following:

Insecticide of Plant Origin: Nicotine, Pyrethroids.

Fungicides: Dichlone, captan

### Unit-2

Structure, synthesis, mode of action, application & environmental impact of following:

Chlorinated hydrocarbon: aldrin, dieldrin, SAR in the class.

### Unit-3

Structure, synthesis, mode of action, application & environmental impact of following:

Organo Phosphorous insecticides: Dichlorovos, Paraoxon, SAR in the class

Dithio phosphoric acid derivatives: Malathion,

Thio phosphoric acid: Parathion, demetron, chlorthion,

Pyrophosphoric acid derivative: TEPP

### Unit-4

Formulation of Pesticides

Dry formulation: Dusts, granules, wettable powders, seed disinfectant.

Liquid formulation: Emulsions, suspensions, aerosols and sprays.

### Recommended Text Books

Medicinal Chemistry by A. Burger, 2002

## ICH-415F: Petrochemicals, Oils & Soaps

### Unit-1

**Petrochemicals:** Constituents of Petroleum, Processing or Refining, Petrochemicals, Feedstock's, Petrochemicals from methane, ethylene, propylene, butylenes and cyclohexane. Manufacture of petrochemical by chemical conversion.

### Unit-2

**Oils:** Edible and nonedible oils, chemical composition and physical properties of vegetable oils, Method of extracting oils, Hydrogenation of oils.

### Unit-3

**Soaps and detergents:** Cleaning agents, Soaps, manufacture of soaps, Glycerin, Methods of production of glycerin, Detergents, manufacture of various kinds of detergents, cleaning action of soaps and detergents, Use Pattern, Saponification value, Acid values, Iodine value, Titer, Rosin value, Total fatty matter.

### Unit-4

**Surfactant & Disinfectant:** Surfactants, classification of surfactant, Raw material of surfactants, Diff Bleaching agents, Function of bleaching agents. Disinfectant, classification of disinfectant, and its application, Phenolic derivative as disinfectant, Phenolic coefficient.

### Recommended Text Books

1. Chemistry of Petrochemical Process, Sami Matar, Lewis F. Hatch, Gulf Professional Publishing. Boston.
2. Fundamental of Petroleum Chemical Technology, P. Belov, Mir Publications, Moscow.
3. Advanced Petroleum Refining, G. N. Sarkar, Khanna Publishers, Delhi.
4. Petrochemicals, Peter Wisheman, John Wiley & Sons, New York
5. Fundamentals of Petroleum and petrochemical Engineering, Uttam Rai Chaudhari, CRC Press, Taylor & Francis group
6. Organic chemistry, warren, oxford university press



## Semester-VIII

### ICH-416F: Practical

(for B.Sc. IC-Hons only)

**Marks (Practical): 100; Time: 8 h in two days;**

**Marks distribution (Practical)**

**Practical: 75 marks**

**Internal Assessment: 25 marks**

#### Experiments

1. Determination of Temporary and Permanent Hardness of given sample of water.  
To determine the  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  hardness of given water sample.
2. To determine the strength of a given  $\text{CuSO}_4$  solution with N/20 sodium thiosulphate solution.
3. Determination of chloride content of a water sample by Mohr's method.
4. Estimation of the following metals in solution V, Cr, Mo, Fe and Ni.
5. To synthesize benzanilide from aniline.
6. To synthesize benzoic acid from benzanilide
7. To prepare phthalamide from phthalic anhydride.
8. To synthesize 2,4,6-tribromoaniline from aniline.
9. To prepare p-nitroacetanilide from acetanilide.
10. To prepare methyl orange from sulphanilic acid.
11. To prepare phenyl azo p-naphthol from aniline.
12. To prepare p-iodoacetanilide from acetanilide.
13. To synthesize phenyl benzoate from phenol.
14. To isolate cellulose from cotton.
15. To isolate p-carotene from carrot.
16. To isolate lycopene from tomato.
17. To isolate caffeine from tea leaves.
18. To extract oleoresin from red chili.
19. To extract clove oil from clove buds through distillation and characterization by melting point, TLC and density.
20. Conductometric titration between strong acid and strong alkali
21. pH measurement and pH titration of strong acid and strong base Study the adsorption of oxalic acid on charcoal and draw the Freundlich isotherm
22. Determination of plastic and dry properties of Ceramic Raw materials.
23. Estimation of moisture in powder/Raste/Cake etc.
24. Determination of specific gravity of material.
25. Determination of dry/green shrinkage of products/fabricated items.
26. Determination of compressive, Tensile strength and MOR of green pieces in proper shape.

## **Semester-VIII**

### **(B.Sc. IC-Research)**

#### **ICH-409F: Analytical Chemistry-I**

##### **Unit-1**

###### **Data Analysis**

Types of errors, propagation of errors, accuracy and precision, significant figures, leastsquare analysis, average, standard deviation, t-test, standardization of analytical methods.

##### **Unit-2**

###### **Titrimetric Methods of Analysis**

General concept, stoichiometric calculations, acid-base titrations, titration curves, acid-base indicators, complexometric titration, metal ion indicator, precipitation titrations, adsorption indicators.

##### **Unit-3**

###### **Gravimetric Methods of Analysis**

Principles of gravimetric analysis, formation and properties of precipitates, applications of gravimetric analysis, organic precipitation.

##### **Unit-4**

###### **Solvent Extraction**

Theoretical principle, classification, factors favouring extraction, extraction equilibrium, Instrumentation and application.

##### **Recommended Text Books**

1. Fundamentals of Analytical Chemistry: D.A. Skoog, D.M. West and F.J. Holler, 1992, 6e
2. Quantitative Inorganic Analysis, A.I. Vogel, 2012, 7e
3. Instrumental Methods of Chemical Analysis: B.K. Sharma, 2011
4. Instrumental Methods of Chemical Analysis: H. Kaur, 2016, 12 e
5. Analytical Chemistry, Gary D. Christian, 2007, 6e
6. Instrumental Methods of Analysis: H.H. Willard, L.L. Merrit, Jr. J.A. Dean, 1974, 5e

## ICH-411F: Organic Chemistry-II

### Unit-1

#### Addition to carbon - carbon multiple bond

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals.

Hydrogenation of double and triple bonds, Hydrogenation of aromatic rings, Hydroboration.

#### Addition to Carbon - Hetero Multiple bond

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl compounds, Wittig reaction.

### Unit-2

#### Elimination Reactions

The E<sub>2</sub>, E<sub>1</sub> and E<sub>1</sub>CB mechanism and their spectrum. Orientation of the double bond. Mechanism and orientation in Pyrolytic elimination.

### Unit 3

Stereochemistry: Stereoselectivity, stereospecificity, conformational, optical isomerism, optical activity, classification of chiral molecules based on symmetry, molecular symmetry and asymmetry, geometrical isomerism.

### Unit 4

Asymmetric synthesis. Retrosynthetic analysis. Application of symmetry in photochemistry and photochemical and pericyclic reactions.

#### Recommended Text Books

1. Stereochemistry of carbon compounds by E. L. Eliel, 1997.
2. Stereochemistry by P. S. Kalsi, 1997.
3. Stereochemistry of Organic compounds By D. Nasipuri, 1994.

## **ICH-417F: Research Project**

(for B.Sc. IC- VIII Sem. Research only)

(12 Credit)

Under the research project, the student can conduct experiments, engage in review writing, perform lab work, or complete dissertation work related to the syllabus of a particular semester, all under the supervision of the assigned mentor.

