National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities/ Colleges
SUBJECT: INDUSTRIAL CHEMISTRY
(For Three Subject Pattern)

Name	Designation	Affiliation
Steering Committee		
Mrs. Monika S. Garg, (I.A.S.) Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
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Dr. Sanjay Jain	Associate Professor, Dept. of Statistics	St. John's College, Agra

Syllabus Developed by:

S. No.	Name	Designation	Department	College/ University
1	**Dr. Sudha Yadava**	Professor & Head	Department of Chemistry	D.D.U. Gorakhpur University, Gorakhpur, U.P.
2	**Dr. Alok Kumar Srivastava**	Associate Professor & Head	Department of Chemistry	Mahatma Gandhi P.G. College, Gorakhpur, U.P.
3	**Dr. Mohd Kamil Hussain**	Assistant Professor	Department of Chemistry	Govt. Raza P.G. College Rampur-244901 U.P.

Department of Higher Education
U.P. Government, Lucknow

National Education Policy-2020

Common Minimum Syllabus for all U.P. State Universities and Colleges
For First Three Years of Higher Education

PROPOSED STRUCTURE OF UG INDUSTRIAL CHEMISTRY SYLLABUS

Syllabus Developed by

S. No.	Name	Designation	Department	College/ University
1	**Dr. Sudha Yadava**	Professor & Head	Department of Chemistry	D.D.U. Gorakhpur University, Gorakhpur, U.P.
2	**Dr. Alok Kumar Srivastava**	Associate Professor & Head	Department of Chemistry	Mahatma Gandhi P.G. College, Gorakhpur, U.P.
3	**Dr. Mohd Kamil Hussain**	Assistant Professor	Department of Chemistry	Govt. Raza P.G. College Rampur-244901 U.P.

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

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Materials and Techniques in Chemical Industries					
1	I	B190101T	Fundamentals of Industrial Chemistry	Theory	4
		B190102P	Basic Analytical Methods	Practical	2
	II	B190201T	Material Science and Techniques in Chemical Industries	Theory	4
		B190202P	Materialistic Analysis	Practical	2
Diploma in Industrial Instrumentation and Chemical Analysis					
2	III	B190301T	Process Instrumentation and Industrial Chemical Analysis	Theory	4
		B190302P	Industrial Chemical and Instrumental Analysis	Practical	2
	IV	B190401T	Process Chemistry	Theory	4
		B190402P	Qualitative and Synthetic Methods	Practical	2
B. Sc. in Industrial Chemistry					
3	V	B190501T	Industrial Chemicals	Theory	4
		B190502T	Pollution, its Management and Industrial Economics	Theory	4
		B190503P	Industrial Chemicals and Pollution Management	Practical	2
		B190504R	Research Project	Project	3
	VI	**Polymer Science (01)***			
		B190601T	Synthetic Polymer	Theory	4
		B190602T	Polymerization Techniques and Characterization	Theory	4
		B190603P	Synthesis and Analysis of Polymers	Practical	2
		B190604R	Research Project	Project	3
		Pharmaceutical Chemistry (02)*			
		B190605T	Pharmaceutical and Phytochemicals	Theory	4
		B190606T	Medicinal Chemistry and Toxicology	Theory	4
		B190607P	Experimental Pharmaceutical Chemistry	Practical	2
		B190608R	Research Project	Project	3
		Agrochemicals (03)*			
		B190609T	General and Halogenated Insecticides	Theory	4
		B190610T	Fungicides and Herbicides	Theory	4
		B190611P	Analysis of Agrochemicals	Practical	2
		B190612R	Research Project	Project	3

*01, 02 & 03 for the elective papers *Polymer Chemistry*, *Pharmaceutical Chemistry* & *Agrochemicals* respectively in semester-VI.

Purpose of the programme:

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*** programme 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 chemistry and various industrial processes.
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 become aware of the role of industrial chemistry in our society. They will be able to use this knowledge on account of ethical behavior in issues faced by chemists in industries for example safe handling of chemicals, environmental issues and key issues faced by our society in energy, health and medicine.
6. Students will be able to explain why industrial 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. Chemical industries in India and throughout the entire world are using increasingly sophisticated chemical procedures 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 able to implement new techniques to minimise the industrial pollution.
9. Graduates in *Industrial Chemistry* may find jobs in various industries like chemical, plastics, pharmaceutical, environmental, paint, food, automobile, petroleum and personal care products.

PROGRAM SPECIFIC OUTCOMES (PSOS)	
Certificate in Materials and Techniques in Chemical Industries	
First Year	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 provides practical knowledge of good laboratories practice (GLP) and various basic analytical methods as well as basic knowledge of advanced materials, ceramics, surface chemistry, crystallization, X-ray powder diffraction, distillation, evaporation, absorption, filtration, extraction, drying and purification of organic compounds. Student will be also able to do to qualitative and quantitative analysis in the laboratory. This certificate course will definitely help to students to get basic knowledge of industrial chemistry on account of chemical and pharmaceutical industries by which they can get better placement in the government and private sector services particularly in the field of food safety, health sector, chemical industries etc.
Second Year	**Diploma in Industrial Instrumentation and Chemical Analysis**
	Diploma in *Industrial Instrumentation and Chemical Analysis* 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 provides sound knowledge of industrial analysis, effluent treatment waste water management, testing of materials, analysis of water, analysis of industrial chemicals and various chemical processes in chemical industries. The knowledge of various instruments, spectroscopic tools and separation technique will make the students skilled to work in industries. Students of diploma course 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.
Third Year	**B. Sc. in Industrial Chemistry**
	Degree in *Industrial Chemistry* 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 processes. Fifth semester of this program provide the basic theoretical and experimental knowledge of pollution management, industrial chemical pollution management and it's economics. Final semester of this program provide specialization in Pharmaceutical chemistry or Polymer chemistry or Agrochemicals. • 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 definitely give value to this course.

Subject: Chemistry									Total Credits of the subject
Year	**Sem.**	**Theory Paper**	**Units**		**Practical Paper**	Units		**Research Project**	
1	I	Fundamentals of Industrial Chemistry	1.	Indian ancient chemistry and fundamentals of chemical calculations	Basic Analytical Methods	1.	Good laboratory practices, Calibration of thermometer and burette	Nil	4+2 = 6
			2.	Atomic structure and Periodic properties		2.	Simple laboratory techniques		
			3.	Chemical bonding, acids and bases		3.	Viscosity and Surface tension of liquids		
			4.	Organic compounds and nomenclature		4.	Preparation of standard solutions		
			5.	Fundamentals of organic chemistry and catalysis					
			6.	Liquid crystal s and solid state					
			7.	Metallurgical operations, metals and alloys					
			8.	Heat, thermodynamics and chemical equilibrium					
	II	Material Science and Techniques in Chemical Industries	1.	Advanced materials and material balance	Materialistic Analysis	1.	Analysis of solution	Nil	4+2 = 6
			2.	Surface chemistry and ceramics		2.	Extraction process		
			3.	Utilities in chemical industry		3.	Refractometer		
			4.	Crystallization		4.	Chromatography		
			5.	X-ray powder diffraction and pharmaceuticals					
			6.	Distillation, evaporation and absorption					
			7.	Filtration, extraction and drying					
			8.	Purification of organic compounds					
2	III	Process Instrumentation and Industrial Chemical Analysis	1.	Chromatography	Industrial Chemical and Instrumental Analysis	1.	Instrumental methods of analysis	Nil	4+2 = 6
			2.	Temperature measuring instruments		2.	Material testing		
			3.	Pressure measuring instruments		3.	Water analysis		
			4.	Liquid level measuring instruments		4.	Industrial analysis		
			5.	Industrial analysis					
			6.	Modern instrumental methods of analysis					
			7.	Spectroscopic methods					
			8.	Effluent treatment and waste water management					
	IV	Process Chemistry	1.	Nitration	Qualitative and Synthetic Methods	1.	Analysis of fuel	Nil	4+2 = 6
			2.	Halogenation		2.	Chemical process		
			3.	Sulphonation		3.	Synthesis of common industrial compounds		
			4.	Oxidation		4.	Limit tests		
			5.	Hydrogenations					
			6.	Alkylation					
			7.	Esterification and hydrolysis					
			8.	Amination					

3	V	Industrial Chemicals	1.	Industrial gases	Industrial Chemicals and Pollution Management	1.	Qualitative and quantitative analysis	Research Project	4+4+2 +3 =13
			2.	Petroleum refining process		2.	Synthesis of organic compound		
			3.	Carbon based chemicals and industrial catalysts					
			4.	Pulp and paper industry					
			5.	Surfactants, Soaps, Detergents and Cosmetics					
			6.	Surfactants, soaps, detergents and cosmetics					
			7.	Cane sugar industry					
			8.	Manufacture of chemicals					
		Pollution, its Management and Industrial Economics	1.	Pollutants, their statutory limits and air pollution		3.	Industrial analysis		
			2.	Water Pollution					
			3.	Pesticide Pollution					
			4.	Solid and gaseous wastes					
			5.	Industrial economics A		4.	Gravimetric and volumetric estimations		
			6.	Industrial economics B					
			7.	Industrial economics C					
			8.	Choice of technology and quality control					
	VI	**Polymer Chemistry (01)**							
		Synthetic Polymer	1.	The science of large molecules	Synthesis and Analysis of Polymers	1.	Preparation of representative polymers	Research Project	4+4+2 +3 =13
			2.	Types & general classification of polymers		2.	Determination of saponification value, viscosity of PMMA and hydroxyl value of a resin		
			3.	Molecular weight and molecular weight distribution					
			4.	Polymer solutions					
			5.	Polymer structure and morphology					
			6.	Synthesis, properties and applications of the following Thermosetting polymers					
			7.	Synthesis, properties and applications of the following Thermoplastics polymers					
			8.	Synthesis, properties and applications of Specific polymers					
		Polymerization Techniques and Characterization	1.	Rheology and mechanical properties of polymers		3.	Material testing		
			2.	Degradation of polymers					
			3.	Polymerization techniques					
			4.	Plastic technology					
			5.	Fiber technology		4.	Determination of molecular weights of the polymers by viscosity measurements and T_g value of phosphate glasses		
			6.	Elastomer technology					
			7.	Additives					
			8.	Compounding					

	Or **Pharmaceutical Chemistry (02)**								
		Pharmaceutical and Phytochemicals	1.	Pharmaceutical industry and pharmacopoeias	Experimental Pharmaceutical Chemistry	1.	Demonstration of various pharmaceutical packaging materials and quality control tests of some materials	Research Project	4+4+2 +3 =13
			2.	Various types of pharmaceutical excipients					
			3.	Evaluation of crude drugs		2.	Active ingredient analysis		
			4.	Surgical dressing, sutures, ligatures					
			5.	Chemical constitution of plants					
			6.	Phytochemicals					
			7.	Various isolation procedures for active ingredients		3.	Evaluation of crude drugs		
			8.	Pharmaceutical quality control and packaging materials					
		Medicinal Chemistry and Toxicology	1.	Pharmacology drugs classification					
			2.	Introduction to medicinal chemistry					
			3.	Drug metabolism					
			4.	Principles of Toxicology		4.	Microbiological testing		
			5.	Microbial fermentation					
			6.	Process of manufacture of the following bulk drugs					
			7.	Biotransformation processes					
			8.	Enzyme systems					
	Or **Agrochemicals (03)**								
		General and Halogenated Insecticides	1.	Types of pest and pesticides	Analysis of Agrochemicals	1.	Isolation and estimation of active ingredients	Research Project	4+4+2 +3 =13
			2.	Inorganic insecticides					
			3.	Insecticides of plant origin					
			4.	Organ phosphorus insecticides:					
			5.	Organothiophosphorus insecticides					
			6.	Carbamate insecticides		2.	Preparation of selected pesticide formulations		
			7.	Chemical and Biofertilizers					
			8.	Chlorinated hydrocarbons					
		Fungicides and Herbicides	1.	Fungicides					
			2.	Organomercuric compounds		3.	Estimation of pesticide residues in food articles		
			3.	Dithiocarbamates					
			4.	Miscellaneous fungicides					
			5.	Herbicides		4.	Isolation of nicotine		
			6.	Fumigants, rodenticides and nematicides					
			7.	Plant growth regulators					
			8.	Formulation of pesticides					

COURSE		SUBJECT: INDUSTRIAL CHEMISTRY					Total Credits of the subject
Year	Sem.	Paper Title		Prerequisite for paper	Elective For Major Subject	Hours per Semester	
Certificate in Materials and Techniques in Chemical Industries	I	Theory-1	Fundamentals of Industrial Chemistry	Chemistry in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci	60	4
		Practical-1	Basic Analytical Methods	Opted Sem-I, Theory Paper-1	Yes Zoo/Bot./Physics/Math/Comp Sci	60	2
	II	Theoty-1	Material Science and Techniques in Chemical Industries	Passed Sem-I	Yes Zoo/Bot./Physics/Math/Comp Sci	60	4
		Pracical-2	Materialistic Analysis	Opted Sem-II, Theory Paper-1	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	2
Diploma in Industrial Instrumentation and Chemical Analysis	III	Theoty-1	Process Instrumentation and Industrial Chemical Analysis	Passed Sem-II	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Pracical-2	Industrial Chemical and Instrumental Analysis	Opted Sem-III, Theory Ppaer-1	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	2
	IV	Theoty-1	Process Chemistry	Passed Sem-III	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-2	Qualitative and Synthetic Methods	Opted Sem-IV, Theory Ppaer-1	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	2
Degree in Industrial Chemistry	V	Theory-1	Industrial Chemicals	Passed Sem-IV	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Theory-2	Pollution, its Management and Industrial Economics	Passed Sem-IV	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-3	Industrial Chemicals and Pollution Management	Opted Sem-V Theory Papers-1 &2	Yes Zoo/Bot./Physics/Math.	60	2
		Research Project	…….	Opted Sem-V Theory Papers-1 &2	……	45	3
	VI	**Polymer Chemistry (01)**					
		Theory-1	Synthetic Polymer	Passed Sem-V	Yes Zoo/Bot./Physics/Math	60	4
		Theory-2	Polymerization Techniques and Characterization	Passed Sem-V	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-3	Synthesis and Analysis of	Opted Sem-VI(01)	Yes	60	2

			Polymers	Theory Papers-1 &2	Zoo/Bot./Physics/Math/Comp Sci. (along with theory paper 1 and paper 2)		
		Research Project	……..	Opted Sem-VI(01) Theory Papers-1 &2	……	45	3
	Or	**Pharmaceutical Chemistry (02)**					
		Theory-1	Pharmaceutical and Phytochemicals	Passed Sem-V	Yes Zoo/Bot./Physics/Math	60	4
		Theory-2	Medicinal Chemistry and Toxicology	Passed Sem-V	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-3	Experimental Pharmaceutical Chemistry	Opted Sem-VI(02) Theory Papers-1 &2	Yes Zoo/Bot./Physics/Math/Comp Sci. (along with theory paper 1 and paper 2)	60	2
		Research Project	……..	Opted Sem-VI(02) Theory Papers-1 &2	……	45	3
	Or	**Agrochemicals (03)**					
		Theory-1	General and Halogenated Insecticides	Passed Sem-V	Yes Zoo/Bot./Physics/Math	60	4
		Theory-2	Fungicides and Herbicides	Passed Sem-V	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-3	Analysis of Agrochemicals	Opted Sem-VI(03) Theory Papers-1 &2	Yes Zoo/Bot./Physics/Math/Comp Sci. (along with theory paper 1 and paper 2)	60	2
		Research Project	…….	Opted Sem-VI(03) Theory Papers-1 &2	……	45	3

Semester-I
Paper-1 (Theory)
Course Title: **Fundamentals of Industrial Chemistry**

Programme: **Certificate in Materials and Techniques in Chemical Industries**	Year: First	Semester: First
Paper-1: Theory		Subject: **Industrial Chemistry**
Course Code: **B190101T**	Course Title: **Fundamentals of Industrial Chemistry**	

Course outcomes:

There is nothing more fundamental to chemistry than the chemical bond. Chemical bonding is the language of logic for chemists. Chemical bonding enables scientists to take the more than 100 elements of the periodic table and combine them in myriad ways to form chemical compounds and materials. Periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements. Reaction mechanism gives the fundamental knowledge of carrying out an organic reaction in a step-by-step manner. This course will provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Students will gain an understanding of chemical calculations, molecular atomic structures, periodic properties, chemical bonding, acids-bases, nomenclature of organic compounds, catalysis, fundamental of organic reactions, knowledge of liquid crystals, solid state, Heat, thermodynamics and chemical equilibrium, metallurgical operations, metals and alloys.

Credits: 4	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Indian ancient chemistry and fundamentals of chemical calculations:** Introduction of Indian ancient chemistry, contribution of Indian chemists in context to the holistic development of modern science and technology. Atomic weight, molecular weight, equivalent weight, mole concept, percentage yield, composition of liquid mixtures and gaseous mixtures, molarity, molality, normality.	06h
II	**Atomic structure and periodic properties** 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.	08h
III	**Chemical bonding, acids and bases** Valence bond theory (VBT), concept of hybridization, hybrid orbitals and molecular geometry, valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, SF_6, SF_4, ClF_3, I_3^-, ClF_2^- and SO_4^{2-} and H_3O^+, molecular orbital theory (MOT), molecular orbital diagrams bond orders of mononuclear and heteronuclear diatomic molecules and ions (N_2, O_2, CO, NO, and their ions) 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	08h

	choice of indicators.	
IV	**Organic compounds and nomenclature:** Classification, generic and trade names of organic compounds, functional group, aliphatic compound (alicyclic & cyclic), aromatic compound, heterocyclic compound, petroleum, natural gas, crude oil.	06h
V	**Fundamentals of organic chemistry and catalysis:** Cleavage of bonds (homolysis and heterolysis), reaction intermediates (carbocation, carbanion and free radicals), electrophiles and nucleophiles, aromaticity: benzenoids and Hückel's rule, inductive effect, electrometric effects, mesomeric effect, resonance, hyperconjugation and stearic effect, tautomerism, isomerism, elementary ideas of stereochemistry (geometrical and optical). homogeneous and heterogeneous catalysis, basic principles, mechanisms, factors affecting the performance, enzyme catalysed reactions, industrially important reactions.	08h
VI	**Liquid crystal and solid state:** 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.	08h
VII	**Metallurgical operations, metals and alloys:** 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.	08h
VIII	**Heat, thermodynamics and chemical equilibrium:** 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-efficient, and fugacity, thermodynamic criteria and equilibrium constant, effect of temperature and pressure on equilibrium constants in gaseous system (formation of ammonia).	08h

Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education (2010).
2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O.K. Medhi, 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. Singh J.,Yadav L.D.S., Advanced Organic Chemistry, Pragati Edition.
6. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education (2012).
7. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press (2008).
8. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press (2012).
9. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
   Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education (2003).
10. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
11. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
12. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
13. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
14. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004)

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

Suggested online links:

1. https://swayam.gov.in/
2. https://nptel.ac.in/courses/112/104/112104113/
3. https://onlinecourses.nptel.ac.in/noc19_ph14/preview
4. http://heecontent.upsdc.gov.in/Home.aspx

5. https://cbpbu.ac.in/userfiles/file/2020/STUDY_MAT/CHEM/liquid%20crystal.pdf
6. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
7. https://nptel.ac.in/courses/104/103/104103071/#
8. https://ncert.nic.in/textbook.php?kech1=0-7

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/12th.

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Semester-I
Paper-2 (Practical)
Course Title: **Basic Analytical Methods**

Programme: **Certificate in Materials and Techniques in Chemical Industries**	Year: First	Semester: First
Paper-2: Practical		Subject: **Industrial Chemistry**
Course Code: **B190102P**	Course Title: **Basic Analytical Methods**	

Course outcomes:

Upon successful completion of this lab course students should be able to know about good laboratory practice (GLP), calibration apparatus, preparation of standard solutions, solutions of various concentrations, estimation of components through volumetric analysis, determination of viscosity, surface tension of liquids and simple laboratory techniques.

Credits: 2	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Practical classes: 60h

Unit	Topics	No. of Lectures
I	**Good laboratory practices, Calibration of thermometer and burette**	05h
II	**Simple laboratory techniques:** Crystallization, fractional crystallization, distillation, fractional distillation, melting point and boiling point determination.	10h
III	**Viscosity and Surface Tension of liquids:** 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.	15h
IV	**Preparation of standard solutions:** 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. 3. 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	30h

Suggested Readings:

1. Saxena Ruchi, Srivastava Alok Kumar, "Read & Do Practical Chemistry", Kitab Mahal, New Delhi, India (2016).
2. Skoog D. A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia (2010).
3. G. Larry Hargis, "Analytical Chemistry: Principles and Techniques" Pearson© (1988)

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

Suggested online links:

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. http://chemcollective.org/vlabs

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)
Course prerequisites: To study this course, a student must have had the chemistry in 12th Class	
Suggested equivalent online courses: ……..	
Further Suggestions: ……..	

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

Programme: **Certificate in Materials and Techniques in Chemical Industries**	Year: First	Semester: Second
Paper-1: Theory		Subject: **Industrial Chemistry**
Course Code: **B190201T**	Course Title: **Material Science and Techniques in Chemical Industries**	

Course outcomes:

Currently, tremendous progress has been made in development of advanced materials for their environmental applications and knowledge has been accumulated of the effects of these advanced materials on and their applications in the environment security, recycling and reuse of raw materials and treatment agents, economic benefits, and potential problems to our society. Upon completion of this theory course students would gain knowledge of various materials, 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.

Credits: 4	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Advanced materials and Material balance** Nanomaterials, superconductors, biomaterials and fullerenes **Material balance without chemical reactions:** Flow diagram for material balance and material balance calculations for distillation, absorption, evaporation, extraction filtration, crystallization. **Material balance involving chemical reactions:** Concepts of stoichiometric equations, limiting reactant, excess reactant, percent excess, conversion, yield, selectivity and liquid phase reaction, gas phase reaction with or without recycle or bypass.	09h
II	**Surface chemistry and ceramics:** Adsorption isotherm, sols, gels, emulsions, micro emulsions, micelles, aerosols, effect of surfactants. Introduction of ceramics, types, manufacturing processes and applications of ceramics.	08h
III	**Utilities in chemical industry:** (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.	08h
IV	**Crystallization:** Equilibrium solubility, super saturation, definition, nucleations, crystallization, equipment-tank crystallizer and circulating liquid evaporator crystallizer.	08h
V	**X-ray powder diffraction and pharmaceuticals:** Introduction, different solid forms and their role in drug development, salts, solvates, co-crystals, characterization of amorphous materials.	09h
VI	**Distillation, evaporation and absorption:** (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

VII	**Filtration, extraction and drying:** (i) Filter media and filter aids, filtration equipment- 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, equipment- tray dryer, rotary dryer, flask dryer, fluid bed dryer, drum dryer, spray dryer.	06h
VIII	**Purification of organic compounds:** Simple crystallization, fractional crystallization, sublimation, simple distillation, fractional distillation, distillation under reduced pressure, steam distillation, azeotropic distillation.	06h

Suggested Readings:

1. W. D. Bowen, H. K. Kingery, D.R. Uhlmann, Introduction to Ceramics, Wiley Publishers, New Delhi (1976)
2. J. A. Kent, J. A. (ed), Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.(1997)
3. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao, Imperial college Press, London (2004).
4. W. D. Callister Jr., D. G. Rethwisch Materials Science and Engineering: An Introduction , John Wiley & Sons (2018) .
5. E. R. Riegel, Industrial Chemistry, Van Nostrand Reinhold Company; 7th Revised edition (1974) .
6. F. H. Northern, Elements of Ceramics, Addision Weslay Publishing Corp (1952).
7. K H. Büchel, H-H. Moretto, D. Werner, Industrial Inorganic Chemistry, Wiley (2008)
8. W.L.F. Armarego W.L.F. Armarego C. Chai, Purification of Laboratory Chemicals, Elsevier (2009)
9. W. L. Mc. Cabe, J. C. Smith & Parriet Unit Operators of Chemical Engineering, Mc. Graw Hill Book Company Singapore, 7th edition (2017)

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

Suggested online links:

1. https://nptel.ac.in/courses/112/106/112106227/
2. https://onlinecourses.nptel.ac.in/noc21_cy45/preview
3. https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod4.pdf
4. https://onlinecourses.nptel.ac.in/noc19_ch31/preview
5. https://nptel.ac.in/courses/113/105/113105015/
6. https://authors.library.caltech.edu/25034/10/BPOCchapter9.pdf (purification)
   chemistry-europe.onlinelibrary.wiley.com/journal/23656549
7. https://onlinelibrary.wiley.com/iucr/itc/Ha/ch7o5v0001/ch7o5.pdf
8. https://link.springer.com/content/pdf/10.1007/s41745-017-0026-4.pdf
   file:///C:/Users/dell/Downloads/144_Sample-Chapter.pdf
9. https://www.slideshare.net/knowledge1995/material-balance-for-multiple-units-without-chemical-equation

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

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 clas12th.

Suggested equivalent online courses:

……..

Further Suggestions:

……..

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

Programme: **Certificate in Materials and Techniques in Chemical Industries**	Year: First	Semester: Second
Paper 2: Practical		Subject: **Industrial Chemistry**
Course Code: **B190202P**	Course Title: **Materialistic Analysis**	

Course outcomes:

Upon completion of this lab course students would gain knowledge of preparing solutions of various concentrations, determination of concentrations, extraction of compounds from solutions, determination of refractive index of materials, molar refractivity and specific reactivity of solutions and chromatographic separations. These techniques and methods are very useful tools in various chemical industries such as pharmaceuticals, petroleum, food and materials.

Credits: 2	**Compulsory**
Max. Marks: 25+75 =100	Min. Passing Marks:

Total No. of Practical classes: 60h

Unit	Topics	No. of Lectures
I	**Analysis of Solution** Molecular weight determination by depression in freezing point and elevation in boiling points.	10h
II	**Extraction process:** Phase diagram, partition coefficient. To find out the partition coefficient of – Iodine between CCl_4 and water Acetic acid between water and benzene.	10h
III	**Refractometer:** 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
IV	**Chromatography:** 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 organic compound by column chromatography.	20h

Suggested Readings:

1. A.I. Vogel, A.R. Tatchell, B.S. Furnis ,A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic chemistry (1989)
2. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell,. Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003).
3. V. D. Athawale, P. Mathur, Experimental Physical Chemistry, New Age International (P) Ltd.
4. G. Svehla**,** Vogel's Qualitative Inorganic Analysis, 7e Pearson (2008).
5. G.D. Christian, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York (2004).
6. Harris, D.C., *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman (2016).

Suggested online links:

1. https://fac.ksu.edu.sa/sites/default/files/vogel_-_practical_organic_chemistry_5th_edition.pdf
2. http://faculty.chas.uni.edu/~manfredi/860-121/ORG%20LAB%20MAN%20S08.pdf
3. https://www.ipinnovative.com/media/open-access-books/Practical_Lab_Manua l_of_

Pharmaceutical_Organic_Chemistry_-1_ Low.pdf

4. https://gtu.ge/Agro-Lib/Vogels_TEXTBOOK_OF_QUANTITATIVE_CHEMICAL_ANALYSIS_5th_ed__-_G_H_Jeffery.MsuCity.pdf

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have had the chemistry in 12th Class

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Semester-III
Paper-1 (Theory)
Course Title: **Process Instrumentation and Industrial Chemical Analysis**

Programme: **Diploma in Industrial Instrumentation and Chemical Analysis**	Year: Second	Semester: Third
Paper-1: Theory		Subject: **Industrial Chemistry**
Course Code: **B190301T**	Course Title: **Process Instrumentation and Industrial Chemical Analysis**	

Course outcomes:
On successful completion of students will gain the knowledge of important topics of industrial chemistry such as chromatography, thermal instrumentations, pressure measuring devices, liquid level measuring instruments, Industrial analysis, Modern instrumental analysis, spectroscopic methods, Effluent treatment**, a**nd waste water management.

Credits: 4	**Compulsory**
Max. Marks: 25+75 = 100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Chromatography:** Principles, methods and applications of paper chromatography, TLC, GLC, HPLC, GLC and GPC.	10h
II	**Temperature measuring instruments:** Glass thermometers, bimetallic thermometer, pressure spring thermometer, vapour field thermometers, resistance thermometers and radiation pyrometers.	07h
III	**Pressure measuring instruments:** Manometers, barometers, bourdan pressure gauge; below type, diaphragm type pressure gauges, macleod gauges, pirani gauges etc.	07h
IV	**Liquid level measuring instruments:** Direct-indirect level measurements, float type liquid level gauge, ultrasonic level gauges; bubbler system, viscosity (Ostwald viscometer), surface tension (stalagmometer) and density (pycnometer) measurement.	8h
V	**Industrial analysis:** 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
VI	**Modern instrumental methods of analysis:** pH and conductivity measurements with special reference to water and soil analysis, optical rotation of chiral compound, spectrophotometer.	4h
VII	**Spectroscopic methods: (**theories applications to simple organic molecules) UV-visible spectroscopy, Infra Red spectroscopy, Raman spectroscopy, NMR Spectroscopy, Mass spectroscopy.	6h
VIII	**Effluent treatment, waste water management:** Principles and equipment 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, sewage treatment plants (STPs)	8h

Suggested Readings:

1. Metcalf and Eddy, Wastewater Engineering Publisher - McGraw-Hill (2013) .
2. H.S. Peavy, D.R. Rowe and G. Tchobanoglous; Environmental Engineering Publisher - McGraw-Hill (2015)
3. M. M. Benjamin, D. F. Lawler, Water Quality Engineering: Physical / Chemical Treatment Processes by La - John Wiley & Sons (2013).
4. V. Ranade V. Bhandari Industrial Wastewater Treatment, Recycling and Reuse, Elsevier (2014)
5. Reynolds P. Richard, Unit Operations and Processes in Environmental Engineering) by T.D. Publisher-CL Engineering (1996).
6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher (2009).
7. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York (2004).
8. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman (2016).
9. Pavia, D. L. *et al. Introduction to Spectroscopy*, 5th Ed. Cengage Learning India Ed.
10. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA (1988).

Suggested online links:

1. https://www.mooc-list.com/tags/physical-chemistry
2. https://www.coursera.org/learn/physical-chemistry
3. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
4. http://heecontent.upsdc.gov.in/Home.aspx
5. https://nptel.ac.in/courses/104/108/104108078/
6. https://nptel.ac.in/courses/104/108/104108124/
7. https://nptel.ac.in/courses/104/106/104106122/

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Semester-III
Paper-2 (Practical)
Course Title: Industrial Chemical and Instrumental Analysis

Programme: **Diploma in Industrial Instrumentation and Chemical Analysis**	Year: Second	Semester: Third
Paper-2: Practical		Subject: **Industrial Chemistry**
Course Code: **B190302P**	Course Title: **Industrial Chemical and Instrumental Analysis**	

Course outcomes:
Students gain knowledge and skill related to this paper are as follows-
Instrumental methods of analysis, Material testing, Water analysis, Use of transducers for measuring flow control and Flow measuring devices- floats.

Credits: 2	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Instrumental methods of analysis:** Use of colorimeter, flame photometer, pH meter, potentiometer, conductometer.	15h
II	**Material testing:** Testing of plastics/rubber, Young's modulus, optical, thermal, mechanical and electrical properties.	15h
III	**Water analysis:** Solid content, hardness, COD and other tests as per industrial specifications.	10h
IV	**Industrial analysis:** Analysis of common raw materials as per the industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.	20h

Suggested Readings:

1. G. D .Christian, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York (2004).
2. D.C. Harris, *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman (2016).
3. E. Stocchi, Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK. (1990).
4. J. A .Kent, (ed) Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi, (1997).
5. Pani, B. Textbook of Environmental Chemistry, I.K. International Publishing House, (2017).
6. A. K .De, Environmental Chemistry, New Age International Pvt, Ltd, New Delhi (2012).
7. S. M .Khopkar,., Environmental Pollution Analysis, New Age International Publishe (2010)
8. B. D. Khosla,.; V. C. Garg,. &A. Gulati, Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
9. C. W. Garland,.Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
10. A. M. Halpern,. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have had the chemistry in 12th Class
Suggested equivalent online courses: ……..
Further Suggestions: ……..

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

Programme: **Diploma in Industrial Instrumentation and Chemical Analysis**	Year: Second	Semester: Fourth
Paper-1: Theory		Subject: **Industrial Chemistry**
Course Code: **B190401T**	Course Title: **Process Chemistry**	

Course outcomes:

Upon completion of this course the students will have the knowledge and skills regarding various chemical process of organic chemistry such as nitration, sulphonation, halogenation, oxidation, hydrogenation, alkylation, ammination, esterification and hydrolysis. These organic chemical processes are important tools to synthesis of important pharmaceuticals or drug molecules and other industrially important organic compounds.

Credits: 4	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Nitration:** Introduction, nitrating agents, mechanism and nitration of paraffin hydrocarbons - benzene to nitrobenzene and m-dinitrobenzene, chlorobenzene to *o*- & *p*-nitrochlorobenzenes, acetanilide to *p*-nitro acetanilide and toluene.	08h
II	**Halogenation:** Introduction, reagents for halogenations, halogenations of aromatics – side chain and nuclear halogenations, commercial manufacture of chlorobenzene, chloral, monochloroacetic acid and chloromethanes.	08h
III	**Sulphonation:** Introduction, sulphonating agents, chemical and physical factors in sulphonation, mechanism of sulphonation, commercial sulphonation of benzene, naphthalene, alkyl benzene.	08h
IV	**Oxidation:** 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	**Hydrogenations:** 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	**Alkylation:** 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	**Esterification and Hydrolysis:** Introduction, esterification reactions by organic acids, commercial manufacture of ethyl acetate, vinyl acetate, cellulose acetate. Introduction, hydrolyzing agents, mechanism of hydrolysis.	08h

VIII	**Amination:** **By reduction:** Introduction, methods of reduction, metal and acid, catalytic sulfide, electrolytic, metal and alkali sulfites, metal hydrides, sodium metal, conc. caustic oxidation-reduction, commercial manufacture of aniline, m-nitroaniline, p-aminophenol. **By aminolysis:** Introduction, aminating agents, factors affecting.	08h

Suggested Readings:

1. R. N. Morrison & R. N. Boyd, *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. P. A. Sykes, *Guidebook to Mechanism in Organic Chemistry*, Pearson Education (2003).
3. F. A. Carey, Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education (2012).
4. G. M. Loudo , *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. J. Clayden, N. Greeves & S. Warren, *Organic Chemistry*, 2nd edition, Oxford University Press (2012).
6. T.W. Graham Solomons & C. B. Fryhle, *Organic Chemistry*, John Wiley & Sons, Inc.
7. J. G. Smith, *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. J. March, *Advanced Organic Chemistry*, Fourth edition, Wiley.
9. Alok Kumar Srivastava, "Organic Chemistry-II", Mahaveer Publication, Dibrugarh, Assam, India (2021).

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

Suggested online links:

1. http://heecontent.upsdc.gov.in/Home.aspx
2. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
3. https://nptel.ac.in/courses/104/103/104103071/#
4. https://swayam.gov.in/

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Semester-IV
Paper-2 (Practical)
Course Title: Qualitative and Synthetic Methods

Programme: **Diploma in Industrial Instrumentation and Chemical Analysis**	Year: Second	Semester: Fourth
Paper-2: Practical		Subject: **Industrial Chemistry**
Course Code: **B190402P**	Course Title: **Qualitative and Synthetic Methods**	

Course outcomes:

Students gain knowledge and skill related to this paper are as follows.

Utilities in chemical industry, distillation, evaporation and absorption, filtration and extraction, drying, crystallization and polymorphism, Fluid Flow, Heat Transfer.

Credits: 2	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Analysis of fuel** Determination of flash point, ignition point of liquids and smoke point of a fuel.	05h
II	**Chemical process** – 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
III	**Synthesis of common industrial compounds:** Each step reaction monitor by TLC. 4-Bromo aniline, 3-Nitroaniline, Sulphanilamide, 4-Amino benzoic acid, 4-Nitro benzoicacid, Dihalobenzenes, Nitrohalobenzenes.	20h
IV	**Limit tests** Limit tests for chlorine, arsenic and heavy metals – Pb, As, Hg, Fe and ash content.	15h

Suggested Readings:

1. A.I. Vogel, A.R. Tatchell, B.S. Furnis , A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic chemistry (1989).
2. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell,. Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003).
3. Organic Chemistry, Prentice-Hall, 5th edition (1996).
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman (1960).
5. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman (2016).
6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher (2009).
7. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education (2012).
8. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson (2009).

Suggestive digital platforms web links:

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. http://chemcollective.org/vlabs

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)
Course prerequisites: To study this course, a student must have Opted Sem-V Theory Ppaer-1 &2	
Suggested equivalent online courses: ……..	
Further Suggestions: ……..	

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

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Fifth
Paper-1: Theory		Subject: **Industrial Chemistry**
Course Code: **B190501T**	Course Title: **Industrial Chemicals**	

Course outcomes:

The chemical industry comprises the companies that produce industrial chemicals. Central to the modern world economy, it converts raw materials into more than 70,000 different products. On successful completion of this course students will gain the knowledge and skills related to various industrial gases, petroleum refining process, carbon based chemicals and industrial catalysts, pulp and paper industry, surfactants, soaps, detergents and cosmetics, cane sugar industry, manufacture of heavy organic chemicals, heavy inorganic chemicals, fine chemicals.

Credits: 4	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Industrial gases:** Manufacture, uses and economics of N_2, O_2, H_2, CO_2.	03h
II	**Petroleum refining process:** Introduction, distillation, octane number, additives, hydro treating, cracking, reforming, alkylation and polymerization, separation of natural gas (methane production).	05h
III	**Carbon based chemicals and industrial catalysts:** Manufacture, properties and uses of methanol, formaldehyde, acetic acid, chloro fluoro carbons and fluoro carbons. 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.	10h
IV	**Pulp and paper industry:** Manufacture of pulp and paper and their uses.	05h
V	**Surfactants, soaps, detergents and cosmetics:** (i) Introduction, cationic and anionic surfactants, straight chain detergent intermediates linear alcohol sulphates (AS), linear alcohol ethoxy sulphates(AES) and linear alkyl benzene sulfonates (LAS), amphoterics and detergent builders (ii) Definition and characteristics of cream, hair dyes, tooth paste, talcum powder, sun tan lotion, perfumes and essential oils.	10h
VI	**Cane sugar industry:** Manufacture of white crystalline sugar, extraction of the juice, clarification (lime defection process, by sulphate ion and by carbonation), evaporation, crystallization and refining of sugar, uses of bagasse.	07h
VII	**Manufacture of heavy organic and inorganic chemicals:** (with respect to raw material, production process, quality control, hazards and safety, effluent management) ***A.*** *Heavy organic chemicals:* 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. ***B.*** *Heavy inorganic chemicals:*	12h

	Ammonium phosphates, carbon blacks, manufacture of graphite and carbon, calcium carbide, silicon carbide, sodium thiosulphate, borax and boric acid.	
VIII	**Manufacture of fine chemicals:** (with respect to Raw material, Production process, Quality control, Hazards and safety, Effluent management) 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.	08h

Suggested Readings:

1. B. K. Sharma, Industrial Chemistry, GOEL Publishing House (2000).
2. M. Fahim, T. Al-Sahhaf, A. Elkilani, Fundamentals of Petroleum Refining, 1st edition, Elsevier Science (2010).
3. Pesticide Calcer Publication, P. B. Pandey.
4. Principle Industrial Chemistry, C. A. Clausion, G. C.Mattson, Wiley (1978).
5. W. L. Mc. Cabe, J. C. Smith & Parriet ,Unit Operators of Chemical Engineering, Mc. Graw Hill Book Company Singapore (2017).
6. A. F. Mills. Heat Transfer, CRC Press, (1992).
7. K.W. Britt, Handbook of pulp and paper technology Book on Pulp & Paper Industries, 2Ed (2004).

Suggestive digital platforms web links:

1. https://nptel.ac.in/courses/103/107/103107082/
2. https://nptel.ac.in/courses/103/103/103103029/
3. https://nptel.ac.in/courses/103/106/103106108/
4. https://nptel.ac.in/courses/104/105/104105103/

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

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Further Suggestions:

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Semester-V
Paper-2 (Theory)
Course Title: Pollution, its Management and Industrial Economics

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Fifth
Paper-2: Theory		Subject: **Industrial Chemistry**
Course Code: **B190502T**	Course Title: **Pollution, its Management and Industrial Economics**	

Course outcomes:

Students gain knowledge and skills related to this paper are 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	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60 h

Unit	Topics	No. of Lectures
I	**Pollutants, their statutory limits and air pollution:** 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.	08h
II	**Water pollution**: 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.	08h
III	**Pesticide pollution**: 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.	08h
IV	**Solid & gaseous wastes**: 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_2, SO_2, NO etc. electrostatic precipitation and bag filters.	10h
V	**Soil economics A**: 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.	06h
VI	**Soil economics B**: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.	06h
VII	**Soil economics C:** 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.	06h
VIII	**Choice of technology and quality control:** Plant and equipments, techno-economic feasibility of the projects, plant layout and process	08h

	planning for the project. Quality control, quality assurance and testing of the product, packaging, advertising and after sales service.	

Suggested Readings:

1. R.K. Trivedy, N.S. Raman, Industrial Pollution and Environmental Management, Scientific Publishers Journals (2002).
2. M. Brusseau, I. Pepper, C. Gerba, Environmental and Pollution Science, Third Edition, Elsevier Science (2019).
3. H. S. Rathore, L.L.L. Nollet, Pesticides: Evaluation of Environmental Pollution, CRC Press (2012).
4. B. K. Sharma, Industrial Chemistry (including Chemical Engineering), GOEL Publishing House (2000).
5. P. F. Rad, Project Estimating & Cost Management, Berrett Kochler Publisher (2001).

Suggestive digital platforms web links:

1. https://nptel.ac.in/courses/105/103/105103205/
2. https://nptel.ac.in/courses/126/105/126105016/
3. https://nptel.ac.in/courses/126/105/126105010/
4. https://nptel.ac.in/courses/105/102/105102089/
5. https://nptel.ac.in/courses/122/106/122106030/
6. https://nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.pdf

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

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Further Suggestions:

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Semester-V
Paper-3 (Practical)
Course Title: Industrial chemicals and pollution management

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Fifth
Paper-3: Practical		Subject: **Industrial Chemistry**
Course Code: **B190503P**	Course Title: **Industrial chemicals and pollution management**	

Course outcomes:
Students gain knowledge and skills related to this paper are 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	**Compulsory**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Qualitative and quantitative analysis:** 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.	10h
II	**Synthesis of organic compound:** Each step reaction monitor by TLC. Paracetamol, Aspirin, oils of winter green and urea formaldehyde resin.	10h
III	**Industrial analysis:** Analysis of common raw materials as per the industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.	20h
IV	Gravimetric and volumetric estimations.	20h

Suggested Readings:

1. Ruchi Saxena, Alok Kumar Srivastava, "Read & Do Practical Chemistry", Kitab Mahal, New Delhi, India, 2016.
7. A.I. Vogel, A.R. Tatchell, B.S. Furnis , A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic chemistry (1989)
2. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003)s

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class.

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-V Theory Ppaer-1 &2

Suggested equivalent online courses:
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Further Suggestions:
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Semester-VI
Paper-1 (Theory)
Course Title: Synthetic Polymer

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-1: Theory		Subject: **Industrial Chemistry**
Course Code: **B190601T**	Course Title: **Synthetic Polymer**	

Course outcomes:

Students gain knowledge and skills related to this paper are as follows.

The science of large molecules, types & general classification of polymers, molecular weight and molecular weight distribution, polymer solutions, structure and morphology, synthesis, properties and applications of the following thermosetting polymers, thermoplastics polymers, conducting polymers, light emitting polymers and biodegradable polymers. This course mainly includes study of polymers synthesis, polymer properties, polymer processing, polymer testing, polymer degradation, polymer reaction, composites and applications. The course is career oriented and can provide various opportunities in the field of polymers.

Credits: 4	**Elective**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**The science of large molecules:** 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	**Types & general classification of polymers:** 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	**Molecular weight and molecular weight distribution:** Number, weight & viscosity average molecular weights of polymers, methods of determining molecular weights, significance of molecular weight distribution.	05h
IV	**Polymer solutions, structure and morphology:** Criteria of polymer solubility, solubility parameters, fractionation of polymers with special reference to gel permeation chromatography.	05h
V	**Polymer structure and morphology:** A brief idea of microstructure of polymers based on chemical and geometrical structures, intermolecular forces and chemical bonding in polymers, linear, branched and cross linked polymers, stereoregular polymers, crystallinity in polymers, effect of crystallinity on the properties of the polymers, factors affecting the crystallinity.	08h
VI	**Synthesis, properties and applications of the following Thermosetting polymers:** Unsaturated polyesters: Fibre reinforced plastics (FRP), Polyurethanes, Phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde, Polycarbonates, Alkyl resins and amino resins, Epoxy resins – grades and curing process and its importance with mechanism, Silicones. Elastomers – polyisoprene, polybutadiene and neoprene.	08h
VII	**Synthesis, properties and applications of the following Thermoplastics polymers:** Polyethylene – HDP, LDP, LLDP. Polyvinyl chloride, PTFE (Teflon).	11h

	Polystyrene – SBR, ABS, SAN. Vinyl polymers – PVA, PVB. Polyacetals, Polyamides – nylon-6, nylon-66 Polyethers and Polyesters – terephthalates (PET). Cellulosic polymers. Acryclic Plastics- PMMA	
VIII	**Synthesis, properties and application of specific polymers:** **1. Conducting polymers:** Polyacetylene (PAc), Polyaniline (PANI), Polythiophene (PTh) **2. Light emitting polymers:** Polyparaphenylene (PPP), Polyparaphenylenevinylene (PPPV), Polyfluorene (PF). **3. Biodegradable polymers:** Polyglycolic acid (PGA),Polyhydroxybutyrate (PHB), Polyhydroxybutyrate-co-valerate (PHBV)	11h

Suggested Readings:

1. U. R. Gowariker, N.V. Vishwanathan and J. Shreedhar, Polymer Science by, New Age International Publishers, New Delhi (1987).
2. H. G. Elias, an introduction to polymer science, Wiley (1997).
3. An Introduction to polymer science and Technology, N. B. Singh, S. S. Das, New age Internal Publisher, New Delhi (2017).
4. P. Chandrasekhar Conducting Polymers, Fundamentals and Applications, Springer (2013).
5. A. Lendlein, A. Sisson, Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications, Wiley-VCH (2011).
6. A. J. Domb, J. Kost, D.d Wiseman, Handbook of Biodegradable Polymers, CRC Press (2019).
7. Handbook of Thermoset Plastics, 4th Edition, Hanna Dodiuk, Elsevier (2021).
8. F.W. Billmeyer, Textbook of polymer Science, John Wiley &Sons, New York (1984).

Suggestive digital platforms web links:

1. https://nptel.ac.in/courses/103/106/105106205/
2. https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod16.pdf
3. https://onlinecourses.nptel.ac.in/noc21_cy50/preview
4. https://nptel.ac.in/courses/103/107/103107139/

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Semester-VI
Paper-2 (Theory)
Course Title: Polymerization Techniques and Characterization

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-2: Theory		Subject: **Industrial Chemistry**
Course Code: **B190602T**	Course Title: **Polymerization Techniques and Characterization**	

Course outcomes:

This course mainly includes study of polymers synthesis, polymer properties, polymer processing, polymer testing, polymer degradation, polymer reaction, composites and applications. This course is career oriented and can provide various opportunities in the field of polymers. After successful completion of this paper, students will 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	**Elective**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Rheology and mechanical properties of polymers:** 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.	10h
II	**Degradation of polymers:** Degradation of polymers by thermal, oxidative, mechanical and chemical methods, random degradation and chain depolymerization.	07h
III	**Polymerization techniques:** A general idea of bulk, solution, suspension, emulsion, polymerization processes.	07h
IV	**Plastic technology:** General concept of plastics; A brief idea of compression molding, injection molding, extrusion and blow molding techniques, thermoforming and foaming, casting, extrusion, fiber spinning, coating and calendaring, vulcanization of elastomers, reinforcing (fiber reinforced plastics - FRP).	10h
V	**Fiber technology:** General concept of fibers; A brief idea of textile and fabric properties, fiber spinning (wet, dry and melt spinning)	08h
VI	**Elastomer technology:** General concept of elastomers; Vulcanization of elastomers, and its chemistry.	08h
VII	**Additives:** A general idea of fillers, plasticizers, antioxidants, colourants, fire retardants, thermal stabilizers.	07h
VIII	**Compounding:** A general idea compounding ingredients etc.	03h

Suggested Readings:

1. Joel R. Fried, Polymer Science &Technology, Pearson Prentice Hall; 3rd edition (2014).
2. B. K. Sharma, Polymer Chemistry,. Krishna Prakashan Media (2020).
3. D. J. Williams, Polymer Science & Engineering, Prentice Hall Inc (1971).
4. J.A. Brydson. Plastics Material, A. Brydson, Vth Edition, Butter Worth Heinemonn (1989).
5. G. Odian, Principle of Polymerization, Godian IInd edition, John Wieley & Sons (2004).

Suggestive digital platforms web links:

1. https://www.digimat.in/nptel/courses/video/103103139/L20.html
2. https://nptel.ac.in/courses/113/105/113105028/
3. https://www.youtube.com/watch?v=GltrPpUJS9Q
4. https://nptel.ac.in/courses/112/107/112107221/
5. https://nptel.ac.in/courses/116/102/116102026/

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

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Further Suggestions:

……..

Semester-VI
Paper-3 (Practical)
Course Title: Synthesis and Analysis of Polymers

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-3: Practical		Subject: **Industrial Chemistry**
Course Code: **B190603P**	Course Title: **Synthesis and Analysis of Polymers**	

Course outcomes:

Students gain knowledge and skills related to this paper are as follows.

Preparation of representative polymers such as bulk polymerization like polystyrene, PMMA Nylon and polysulphide rubber, solution polymerization like phenol formaldehyde, urea formaldehyde, determination of (i) saponification value - polyester (ii) viscosity of PMMA (iii) hydroxyl value of a resin, testing of plastics/rubber, Young's modulus, optical, thermal, mechanical and electrical properties, determination of molecular weights of the polymers by viscosity measurements and T_g value of phosphate glasses.

Credits: 2	**Elective**
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Preparation of representative polymers:** Bulk polymerization: Polystyrene, PMMA Nylon and polysulphide rubber Solution polymerization: Phenol formaldehyde, urea formaldehyde	15h
II	Determination of (i) saponification value - polyester (ii) viscosity of PMMA (iii) hydroxyl value of a resin.	15h
III	**Material testing:** Testing of plastics/rubber, Young's modulus, optical, thermal, mechanical and electrical properties.	15h
IV	Determination of molecular weights of the polymers by viscosity measurements and T_g value of phosphate glasses.	15h

Suggested Readings:

1. J. B. Rabek, Experimental methods In Polymer Chemistry, Wiley–Blackwell (1980).
2. D. G. Hundiwale, Experiments In Polymer Science Paperback, New Age International Private Limited; First edition (2008).
3. T. Tanaka, Experimental Methods in Polymer Science, Academic Press (1999).

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-VI Theory Ppaer-1 &2

Suggested equivalent online courses:

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Further Suggestions:

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Semester-VI
Paper-1 (Theory)
Course Title: Pharmaceutical and Phytochemicals

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-1: Theory		Subject: **Industrial Chemistry**
Course Code: **B190605T**	Course Title: **Pharmaceutical and Phytochemicals**	

Course outcomes:

After successful completion of this course, students will gain the knowledge and skills related to this paper are 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	**Elective**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Pharmaceutical industry and Pharmacopoeias:** 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 roots of administration, aseptic conditions, need for sterilization, various methods of sterilization.	06h
II	**Various types of pharmaceutical excipients:** 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	**Evaluation of crude drugs:** Moisture contents, extractive value, volatile oil content, foreign organic matter, quantitative microscopic exercises including of starch, leaf content (palisade ratio, stomatal number, vein islet number and vein termination number) and crude fiber content, various isolation procedures for active ingredients.	10h
IV	**Surgical dressing, sutures, ligatures**- with respect to the process, equipments used for manufacture, methods of sterlization and quality control.	06h
V	**Phytochemicals:** Introduction to plant classification and crude drugs, cultivation, collection, preparation for the market and storage of medicinal plants.	08h
VI	**Chemical constitution of plants**: including carbohydrates, amino acids, proteins, fats, waxes, volatile oils, terpenoids, steriods, saponins, flavonoids, tannins, glycosides, alkaloids.	08h
VII	**Various isolation procedures for active ingredients:** With example for alkaloid, e.g., vincaalkaloids, reserpine; one for steriods- sapogenin, diosgenin, diagroh.	08h
VIII	**Pharmaceutical quality control and packaging materials:** Sterility testing, pyrogenic testing, glass testing, bulk density of powders, etc. (other than the analytical methods covered under core subject), ancillary materials, packaging machinery, quality control of packaging materials.	08h

Suggested Readings:

1. L. Patrick. L. Graham, An Introduction to Medicinal Chemistry, OUP Oxford; 4th edition (2009).
2. C. O. Wilson, O. Gisvold & R. F. Doerge, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins; 8th edition (1982).
3. W. O. Foye, T. L. Lemice and D. A. Williams Principles of Medicinal Chemistry (2019).
4. D J. Abraham, M. Myers, Burger's Medicinal Chemistry, Drug Discovery and Development (1-8 volume), Wiley (2021).
5. G.L. Patrick, An Introduction to Medicinal Chemistry, Oxford; Fifth edition (2013).
6. John T. Arnason, Rachel Mata, John T. Romeo, Phytochemistry of Medicinal Plants, Springer (2019).

Suggestive digital platforms web links:

1. https://nptel.ac.in/courses/104/106/104106106/
2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cy16/
3. https://nptel.ac.in/LocalChapter/statistics/2537

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

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Further Suggestions:

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Semester-VI
Paper-2 (Theory)
Course Title: Medicinal Chemistry and Toxicology

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-2: Theory		Subject: **Industrial Chemistry**
Course Code: **B190606T**	Course Title: **Medicinal Chemistry and Toxicology**	

Course outcomes:

Medicinal chemistry provides pharmacy students with a thorough understanding of drug mechanisms of action, acid-base and physicochemical properties, and absorption, distribution, metabolism, excretion, and toxicity profiles. Students gain knowledge and skills related to this paper is as follows. pharmacology drugs classification, Introduction to medicinal chemistry, drug metabolism, principles of toxicology, Biotransformation processes and Enzymes

Credits: 4	**Elective**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Pharmacology and Drugs classification:** 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.	08h
II	**Introduction to medicinal chemistry**: History and development of medicinal chemistry, physicochemical properties in relation to biological action, ionization, solubility, partition coefficient, hydrogen bonding, protein binding, chelation, bioisosterism, optical and geometrical isomerism..	08h
III	**Drug metabolism:** Drug metabolism principles- phase I and phase II, factors affecting drug metabolism including stereo chemical aspects.	06h
IV	**Principles of Toxicology:** Definition of poison, general principles of treatment of poisoning with particular reference to barbiturates, opioids, organophosphorous and atropine poisoning, heavy metals and heavy metal antagonists.	06h
V	**Microbial fermentation:** 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.	06h
VI	**Process of manufacture of the following bulk drugs:** (i) Sulpha drugs- Sulphaguadine, Sulphamethoxazole (ii) Antimicrobial- Chloraamphenicol, Furazolidine, Mercurochrome, Isoniazid, Na- PAS (iii) Antalgesic- 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.	16h

	(x)Antibiotics drugs – Penicillin-G, semi synthetic penicillin, Rifamycin, Tetracycline, and Vitamin-B12. (xi)Antimalarial drugs. Anticancerous drugs. AntiAIDS vaccines.	
VII	**Biotransformation processes**- for prednisolone, 11-hydroxylation in steroids, enzyme catalyzed transformation, manufacture of ephidrine.	05h
VIII	**Enzyme systems** - useful for transformation, microbial products, enzyme catalyzed transformation - manufacture of ephedrine.	05h

Suggested Readings:

1. M.E. Wolff, Burgers Medicinal Chemistry and Drug Discovery Wiley–Blackwell; 5th edition (1997).
2. W. David, Pharmaceutical Chemistry, Elsevier-Health U.K. (2011).
3. C. Donald, Essential of Pharmaceutical Chemistry, Pharmaceutical press, London (2012).
4. L. Patrick. L. Graham, An Introduction to Medicinal Chemistry, OUP Oxford; 4th edition (2009).
5. C. O. Wilson, O. Gisvold & R. F. Doerge. Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins; 8th edition (1982).
6. W. O. Foye, T. L. Lemice and D. A. Williams Principles of Medicinal Chemistry (2019).
7. D J. Abraham, M. Myers, Burger's Medicinal Chemistry, Drug Discovery and Development (1-8 volume), Wiley (2021).
8. G.L. Patrick, An Introduction to Medicinal Chemistry, Oxford; Fifth edition (2013).
9. John T. Arnason, Rachel Mata, John T. Romeo, Phytochemistry of Medicinal Plants, Springer (2019).

Suggestive digital platforms web links:

1. https://nptel.ac.in/courses/104/106/104106106/
2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cy16/
3. https://nptel.ac.in/LocalChapter/statistics/2537/
4. https://onlinecourses.nptel.ac.in/noc20_cy16/preview
5. https://onlinecourses.nptel.ac.in/noc21_cy05/preview
6. https://chemistry-europe.onlinelibrary.wiley.com/journal/23656549
7. https://www.griffith.edu.au/study/courses/principles-of-toxicology-2021PHM#trimester-1-gold-coast-campus

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Further Suggestions:

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Semester-VI
Paper-3(Practical)
Course Title: Experimental Pharmaceutical Chemistry

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-3: Practical		Subject: **Industrial Chemistry**
Course Code: **B190607P**	Course Title: **Experimental Pharmaceutical Chemistry**	

Course outcomes:

Students gain knowledge and skills related to this paper is as follows.

Demonstration of various pharmaceutical packaging materials, quality control tests of some materials- aluminium strips, cartons, glass bottles, 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.

Credits: 2	**Elective**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	Demonstration of various pharmaceutical packaging materials and quality control tests of some materials- aluminium strips, cartons, glass bottles.	10h
III	**Active ingredient analysis** of few types of formulations representing different methods of analysis- acidmetry, alkametry, nonaqueous complexometry, potentiometry, etc.	10 h
IV	**Evaluation of crude drugs**- microscopic examination- determination and identification of starch granules, calcium oxalate.	20 h
V	**Microbiological testing**- Determination of MIC of some antibacterial and antifungal drugs by zone/cup plate methods.	20h

Suggested Readings:

1. Dickson, Experiments in Pharmaceutical Chemistry, CRC Press (2014).
2. S. K. Dwivedi, Practical Lab Manual of Pharmaceutical Organic Chemistry – I, IP, innovative publication pvt ltd (2014).
3. C. Kokare Pharm. Biotechnology Experiments & Techniques - Pharmaceutical Biotechnology - Experiments and Techniques Fifth Edition, Nirali Prakashan (2019).

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-VI Theory Ppaer-1 &2

Suggested equivalent online courses:
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Further Suggestions:
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Semester-VI
Paper-1 (Theory)
Course Title: General & Halogenated Insecticides

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-1 Theory		Subject: **Industrial Chemistry**
Course Code: **B190609T**	Course Title: **General & Halogenated Insecticides**	

Course outcomes:

Agrochemicals are used for preventing the deterioration of crops from insects and pest infestation and disease. The global agrochemicals market report offers the latest trends, growth factors, industry competitiveness, investment opportunities and detailed profile of the top players for the market during the forecast period. The global agrochemicals market is segmented by product type (fertilizers, pesticides, adjuvants, and plant growth regulators), application (crop-based and non-crop based) and geography.

Students gain knowledge and skills related to this paper are 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	**Elective**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Types of pest and pesticides:** Stomach poison, contact poisons systemic poisons, fumigants. Effect of pesticides on soil and environment.	07h
II	**Inorganic insecticides:** Arsenic insecticides, Paris green, Fluoro insecticides.	04h
III	**Insecticides of plant origin:** Nicotine, Nornicotine, Pyrethroids, Rotenoids, Anabasin, Aliethrin	04h
IV	**Organophosphorus insecticides:** **Phosphoric acid derivatives-** Dimecron, dichlorovos, naled, phosphinon, etc. SAR in the class.	05h
V	**Organothiophosphorus insecticides:** **Thiophosphoric acid derivatives-** Parathion, Methyl parathion, Thiophos, Demetron, Chlorthion, Paraoxon, etc. **Dithiophosphoric acid derivatives-** Melathion, Dimethoate, Thiocron, Formathion, Mecarbam, etc.	12h
VI	**Carbamate insecticides:** Carbaryl, Isolan, Mesurol, Zactran, Demetram, Pyrolan, Baygon, mode of action.	08h
VII	**Chemical and Biofertilizers:** Introduction, Types of fertilizer, direct application fertilizers, mixed fertilizers (nitrogen, phosphorus and potassium sources, ammoniation), controlled release fertilizers and biofertilizers, liquid vs solid fertilizers, biopesticides.	08h
VIII	**Chlorinated hydrocarbons:** DDT, DDD, Nestran, 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

Suggested Readings:

1. Knowles, Alan (Ed.) "Chemistry and Technology of Agrochemical formulations" Springer Netherland (1998)
2. J. P. Kumar and S. Bharat " Soil fertility, Fertilizers and Agrochemicals, Daya Publishing House (2016)
3. H. Ohkawa, H. Miyagawa, P. W. Lee Pesticide Chemistry: Crop Protection, Public Health, Environmental Safety, Wiley (2007).
4. R. Pohanish, Sittig's Handbook of Pesticides and Agricultural Chemicals, Elsevier Science (2014)
5. D. Adams Insecticides and Pesticides: Techniques for Crop Protection, Larsen and Keller Education (2017).
6. B. L. Bohmont, *The standard pesticide user's guide (revised)*. Prentice Hall: Princeton, NJ (1990).
7. G.W. Ware, *The Pesticide Book*, 4th ed; W.H. Freeman: Fresno, CA (1994).

Suggestive digital platforms web links:

1. https://nptel.ac.in/courses/103/107/103107086/
2. https://nptel.ac.in/courses/103/107/103107082/
3. chemistry-europe.onlinelibrary.wiley.com/journal/23656549
4. https://www.youtube.com/watch?v=qspUM9tV5WY
5. https://nptel.ac.in/courses/126/104/126104003/
6. https://onlinecourses.swayam2.ac.in/cec20_bt13/preview
7. https://www.mooc-list.com/tags/agrochemicals?__cf_chl_jschl_tk__=pmd_5O5PKDKzkF2LT66i4kE9EjwggvWfiWI2mhh8Q7oAYwA-1631360062-0-gqNtZGzNAeWjcnBszQjR

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

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Further Suggestions:

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

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-2: Theory		Subject: **Industrial Chemistry**
Course Code: **B190610T**	Course Title: **Fungicides and Herbicides**	

Course outcomes:

Fungicides, herbicides and insecticides are all pesticides used in plant protection. Herbicides are a broad class of pesticides that are used to remove nuisance plants, such as grasses and weeds that may compromise the growth and yield of desired crops that are in close proximity. After successful completion of this paper, Students gain knowledge and skills related to this paper are as follows-

Fungicides, organomercuric compounds, dithiocarbamates, miscellaneous fungicides, herbicides, fumigants, rodenticides, nematicides, plant growth regulators, formulation of pesticides.

Credits: 4	**Elective**
Max. Marks: 25+75=100	Min. Passing Marks:

Total No. of Lectures: 60h

Unit	Topics	No. of Lectures
I	**Fungicides**: Introduction, Sulphur, lime sulphur, copper sulphate, bordeaux mixture, bordeaux paste, bordeaux paint, burgundy mixture, copper oxychloride, cuprous oxide, mercurous chloride.	08h
II	**Organomercuric compounds**: Ethyl mercuric chloride, ceresan-M, panagen, agalol, uspulan, puratized, germisan; mode of action, agrosan GN.	08h
III	**Dithiocarbamates**: Ziram, ferbam, thiram, nabam, zineb, maneb, captan, hinosan, vapam, etc.; mode of action.	06h
IV	**Miscellaneous fungicides**: Dithanon, diclone, captan, polpet, diflolatan, mesulfan, brestan, dodine, glyodin, methyrimol, terrazole.	08h
V	**Herbicides:** Introduciton, heterocyclic nitrogen herbicides: 2,4-D; 2,4-DB; 2,4-DES; MCPB; 2,4,5-I, Monujron, fenuron, TCA, paraquat.	06h
VI	**Fumigants**: HCN, CS_2, ethylene halides, durofume, methyl halides. **Rodenticides**: Zice phosphide, warfarin **Nematicides**: DD mixture, aldicarb, fensulfothion	08h
VII	**Plant growth regulators:** Introduction, gibberilic acids, indole acetic and butyric acids, naphthalene acetic acid, cycocil, mode of action.	08h
VIII	**Formulation of pesticides:** Dry formulations- Dusts, grannules, wettable powders, seed disinfectants, liquid formulations- emulsions, suspensions, etc., aerosols and sprays.	08h

Suggested Readings:

1. P. N. Nene, Y. L. Thapliyal , Fungicides in Plant Disease Control, Medtech (2017).
2. H. Panda,The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides with Formulae & Processes, National Institute of Industrial Research (2003).
3. Knowles, Alan (Ed.) "Chemistry and Technology of Agrochemical formulations" Springer Netherland (1998)
4. J. P. Kumar and S. Bharat "Soil fertility, Fertilizers and Agrochemicals, Daya Publishing House (2016).
5. C.T. Lacal, Plant growth regulators, Arcler Education Inc (2017).
6. E. E. Fletcher, R. C. Kirkwood, Herbicides and Plant Growth Regulators, Methuen (1981).
7. C.L .Foy, C. L. (ed.) *Adjuvants for Agrichemicals*, CRC Press, Boca Raton, FL. (1992).

This course can be opted as an elective by 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	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit 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 chemistry in class 12th

Suggested equivalent online courses:

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Further Suggestions:

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Semester-VI
Paper-3 (Practical)
Course Title: Analysis of Agrochemicals

Programme: **Degree in Industrial Chemistry**	Year: Third	Semester: Six
Paper-3: Practical		Subject: **Industrial Chemistry**
Course Code: **B190611P**	Course Title: **Analysis of Agrochemicals**	

Course outcomes:

Students gain knowledge and skills related to this paper are 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 or tea leaves/ wastes.

Credits: 2	**Elective**
Max. Marks: 25+75=100	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	Isolation of nicotine from tobacco leaves/ wastes or Tea leave	24h

Suggested Readings:

1. B. S. Furniss, A.J. Hannaford, P.W. G. Smith, A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003).
2. Lab manual 11, FSSAI Manual of methods of analysis of foods https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/PESTICIDE_RESIDUE.pdf
3. D. A. Knowles, *Chemistry and technology of agricultural formulations*. Kluwer Academic, London (1998).
4. S. Ippolito, J. R Mendieta, Formulations of Agrochemicals, Scitus Academics Llc (2020).
5. A. Knowles, Chemistry and Technology of Agrochemical Formulations, Springer, 1998.

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-VI Theory Ppaer-1 &2 (**General & Halogenated Insecticides and Fungicides and Herbicides)S**

Suggested equivalent online courses:

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Further Suggestions:

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