Integral University, Lucknow
Department of Chemistry

Study and Evaluation Scheme

Program: B.Sc. (Hons.) Industrial Chemistry **Semester: First**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA		Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
							UE	TA												
THEORIES																				
1.	LN104	Essential Professional Communication	Foundation	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓				✓	✓
2.	MT108	Elementary Mathematics	Foundation	3	1	0	40	20	60	40	100	3:1:0	4	✓		✓				
3.	CH103	Physical Chemistry-I	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓		✓		✓		
4.	CH104	Inorganic Chemistry –I	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓		✓				
5.	CH105	Organic Chemistry-I	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
PRACTICALS																				
6.	CH106	Industrial Chemistry Lab-1	Core	0	0	8	40	20	60	40	100	0:0:4	4	✓	✓	✓		✓		✓
			Total	**15**	**5**	**8**	**240**	**120**	**360**	**240**	**600**	**15:5:4**	**24**							

Program: B.Sc. (Hons.) Industrial Chemistry **Semester: Second**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA		Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
							UE	TA												
THEORIES																				
1.	CS110	Basics of Computer	Foundation	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		✓
2.	CH107	Environmental Pollution	Foundation	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓	✓	
3.	CH108	Physical Chemistry-II	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓		✓		✓		
4.	CH109	Inorganic Chemistry-II	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓						
5.	CH110	Organic Chemistry-II	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
PRACTICALS																				
6.	CH111	Industrial Chemistry Lab-2	Core	0	0	8	40	20	60	40	100	0:0:4	4	✓	✓	✓		✓		
			Total	**15**	**5**	**8**	**240**	**120**	**360**	**240**	**600**	**15:5:4**	**24**							

Integral University, Lucknow
Department of Chemistry

Study and Evaluation Scheme

Program: B.Sc. (Hons.) Industrial Chemistry **Semester: Third**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA		Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
							UE	TA												
THEORIES																				
1.	CH201	Industrial Aspects of Physical Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4			✓				
2.	CH202	Industrial Aspects of Inorganic Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓					
3.	CH203	Industrial Aspects of Organic Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓				
4.	CH204	Materials & Energy Balance	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓		✓				✓
5.	CH205	Industrial Aspects of Microbiology	Elective	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓	✓	✓
	CH206	Biochemistry	Elective	3	1	0	40	20	60	40	100			✓		✓			✓	
PRACTICALS																				
6.	CH207	Industrial Chemistry Lab-3	Core	0	0	8	40	20	60	40	100	0:0:4	4	✓	✓	✓			✓	✓
Total				**15**	**5**	**8**	**240**	**120**	**360**	**240**	**600**	**15:5:4**	**24**							

Program: B.Sc. (Hons.) Industrial Chemistry **Semester: Fourth**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA		Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
							UE	TA												
THEORIES																				
1.	CH208	Polymer Science	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓				
2.	CH209	Medicinal Drugs Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓			✓	✓
3.	CH210	Petro-chemicals	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓		✓				
4.	CH211	Agro-chemicals	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
5.	CH212	Industrial Waste Treatment	Elective	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓	✓	
	CH213	Water treatment and analysis	Elective	3	1	0	40	20	60	40	100			✓	✓	✓		✓	✓	
PRACTICALS																				
6.	CH214	Industrial Chemistry Lab-4	Core	0	0	8	40	20	60	40	100	0:0:4	4	✓	✓	✓		✓	✓	
Total				**15**	**5**	**8**	**240**	**120**	**360**	**240**	**600**	**15:5:4**	**24**							

Integral University, Lucknow
Department of Chemistry

Study and Evaluation Scheme

Program: B.Sc. (Hons.) Industrial Chemistry **Semester: Fifth**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA		Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
							UE	TA												
THEORIES																				
1.	CH301	Chromatographic Techniques	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
2.	CH302	Process in Organic Chemicals Manufacture	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓				
3.	CH303	Phytochemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓				✓	✓	✓
4.	CH304	Unit Operations in Chemical Industry	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓				✓
5.	CH305	Pulp, Paper, Leather and Textile Industry	Elective	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
	CH306	Dyes	Elective	3	1	0	40	20	60	40	100			✓	✓	✓		✓		
PRACTICALS																				
6.	CH307	Industrial Chemistry Lab-5	Core	0	0	8	40	20	60	40	100	0:0:4	4	✓	✓	✓				
			Total	**15**	**5**	**8**	**240**	**120**	**360**	**240**	**600**	**15:5:4**	**24**							

Program: B.Sc. (Hons.) Industrial Chemistry **Semester: Sixth**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA		Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
							UE	TA												
THEORIES																				
1.	CH308	Spectroscopic Techniques	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓				
2.	CH309	Chemical Process Industry	Core	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓				✓
3.	CH310	Fundamentals of Food Chemistry	Elective	3	1	0	40	20	60	40	100	3:1:0	4	✓	✓	✓			✓	
	CH311	Dairy Chemistry	Elective	3	1	0	40	20	60	40	100			✓	✓	✓			✓	
PROJECT/ PRESENTATION																				
4.	* CH312	Project Training (3 months)	Core	00	00	00	00	00	00	300	300	10	10	✓	✓	✓			✓	✓
5.	CH313	Oral Presentation	Core	00	00	08	00	00	00	100	100	0:0:4	4			✓			✓	
			Total	**9**	**3**	**8**	**120**	**60**	**180**	**520**	**700**	**9:3:14**	**26**							

*** The Evaluation scheme for the Projectl Training:**

	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Project & Training	CH312	200	50	50	300

L= Lecture, **T**= Tutorial, P = Practical, **CA**= Continuous Assessment, **UE**= Unit Exam. **TA**= Teacher's Assessment, **ESE**= End Semester Examination; **Sessional**=CT+TA; **Subject Total**= Sessional+ESE

SEMESTER – I

1. Name of the Department: LANGUAGE						
2. Course Name	**ESSENTIAL PROFESSIONAL COMMUNICATION**			**L**	**T**	**P**
3. Course Code	**LN104**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:**

- Developing the art of communication and learning language though literature
- Knowledge of Professional, Cultural and Cross-Cultural Communication
- Basic concept of structural and functional grammar; meaning and process of communication, verbal and nonverbal communication
- Knowledge of Reading and Comprehension of general and technical articles, precise writing, summarizing, abstracting
- Basic concepts of group discussion, organizing seminars and conferences
- Development of Listening , Speaking ,Reading & Writing skills (LSRW)

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Basic Understanding of communication and Professional Communication
CO2	Basic knowledge of structural and functional grammar. Learning Language through literature.
CO3	Basic tools of communication and improvement in communicative competence.
CO4	Understanding the basic grammar and basic structure of language
CO5	Enhancement of writing skills in English i.e. writing application, report and various types of letters.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: PROFESSIONAL COMMUNICATION**

Professional Communication: Its meaning & importance, Essentials of Effective Communication, Barriers to Effective Communication, The Cross Cultural Dimensions of Professional Communication

Unit-2	**Number of lectures =08**	**Title of the unit: LANGUAGE THROUGH LITERATURE**

A. Essays “The Effect of the Scientific Temper on Man” by Bertrand Russell “The Aims of Science and Humanities” by Moody E. Prior
B. Short Stories “The Meeting Pool” by Ruskin Bond “The Portrait of a Lady” by Khushwant Singh

Unit-3	**Number of lectures = 08**	**Title of the unit: BASIC VOCABULARY**

Euphemism , One-word Substitution, Synonyms, Antonyms, Homophones, Idioms and Phrases, Common mistakes, Confusable words and expressions, Portmanteau words, Foreign words and expressions.

Unit-4	**Number of lectures = 08**	**Title of the unit: BASIC GRAMMER**

Articles, Prepositions, Tenses, Concord (Subject-Verb agreement), Modal Auxiliaries, Verbs: its Kind & Uses, Degrees of Comparison, Punctuation.

Unit-5	**Number of lectures = 08**	**Title of the unit: BASIC COMPOSITION**

Report writing: What is a report? Kinds and objectives of reports, writing reports. Business Letter writing: Introduction to business letters, types of business letters, Layout of business letters, Letter of Enquiry / Complaint Proposal writing.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Basic Understanding of communication and Professional Communication	**3**	**1**	**1**		**2**	**1**	**1**
CO2	Basic knowledge of structural and functional grammar. Learning Language through literature.	**3**	**1**	**1**		**2**	**1**	**1**
CO3	Basic tools of communication and improvement in communicative competence.	**3**	**1**	**2**		**2**	**1**	**1**
CO4	Understanding the basic grammar and basic structure of language	**3**	**1**	**2**		**2**	**1**	**1**
CO5	Enhancement of writing skills in English i.e. writing application, report and various types of letters.	**2**	**1**	**2**		**2**	**1**	**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

SEMESTER – I

1. Name of the Department: MATHEMATICS						
2. Course Name	**ELEMENTARY MATHEMATICS**			**L**	**T**	**P**
3. Course Code	**MT108**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	10+2 with Mathematics	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. **COURSE OBJECTIVES:** The course is aimed to develop the skills in mathematics, which is necessary for grooming them into successful science graduate. The topics introduced will serve as basic tools for specialized studies in science field.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.
CO2	Familiar with numerical solutions of nonlinear equations in a single variable.
CO3	Familiar with finite difference and different type interpolation technique.
CO4	Familiar with calculation and interpretation of errors in numerical method.
CO5	Familiar with statistical analysis.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit:

Calculus: Limits and functions, definition of differential coefficient, differentiation of functions including function of a function, differentiation of parametric form, simple and successive differentiation.

Unit-2	Number of lectures =08	Title of the unit:

Integration: Integration as inverse of differentiation, Indefinite integrals of standard form, Integration by parts, substitution method and partial fraction method. Evaluation of definite integrals.

Unit-3	Number of lectures = 08	Title of the unit:

Statistics: Basic concepts of simple random sampling and atartified random sampling, measures of central tendency (mean, median and mode), measures of variation (mean deviation and standard deviation). Covariance, Karl Pearson's Coefficient of Correlation. Regression, method of least squares.

Unit-4	Number of lectures = 08	Title of the unit:

Permutation, Combination and Binomial Theorem: Fundamental principle of counting, Permutations, permutations under certain conditions. Combinations, Combinatorial identities. Binomial theorem (without proof) , some applications of Binomial theorem.

Unit-5	Number of lectures = 08	Title of the unit:

Probability: Random experiment and associated sample space, events,definition of probability, algebra of events, addition and multiplication theorems on probability (without proof). Binomial, Poisson and Normal distributions analysis.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.	**3**	**2**	**2**	**1**	**1**	**3**	**1**
CO2	Familiar with numerical solutions of nonlinear equations in a single variable.	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO3	Familiar with finite difference and different type interpolation technique.	**3**	**2**	**3**	**1**	**1**	**2**	**1**
CO4	Familiar with calculation and interpretation of errors in numerical method.	**3**	**2**	**3**	**1**	**1**	**3**	**2**
CO5	Familiar with statistical analysis.	**3**	**2**	**1**	**1**	**1**	**2**	**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/111107105/lec6.pdf
2. https://nptel.ac.in/content/storage2/courses/122104018/node114.html
3. https://nptel.ac.in/courses/111107062/
4. https://www.yumpu.com/en/document/view/8662778/derivation-of-runge-kutta-method-nptel
5. https://www.youtube.com/watch?v=ntWKMkXAuDA

13. Books recommended:

1. Murray R. Spiegel, 1980, Probability and Statistics, Schaum's (Outline Series) McGraw-Hill Book Co.
2. Q. S. Ahmad, V. Ismail and S. A. Khan: Biostatistics, Laxmi Publications Pvt. Ltd.
3. E. Kreyszig, "Advanced Engineering Mathematics", 5th Edition, Wiley Eastern, 1985.
4. Mathematics, NCERT.
5. Higher Engineering Mathematics, B. V. Ramana. Tata McGraw Hill Publishers

SEMESTER – I

1. Name of the Department: CHEMISTRY						
2. Course Name	**PHYSICAL CHEMISTRY – I**			**L**	**T**	**P**
3. Course Code	**CH103**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** The purpose of this undergraduate course is to impart basic and key knowledge of physical chemistry. By using the principal of physics and mathematics to obtain quantitative relations which are very important for higher studies. After successfully completion of course, the student will able explore subject into their respective dimensions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students would get inside the sound knowledge of gas and their properties and examine the relationships between gas temperature, pressure, amount, and volume.
CO2	Students would able to understand the interfacial phenomena and behaviour of colloidal systems.
CO3	Students would the restate definition of system, surrounding, closed and open system, extensive and intensive properties.
CO4	Students would able to apply First law of thermodynamics and Hess law of heat summation and perceive the concept of Enthalpy.
CO5	Students would able to understand the basic definitions and terms in a phase diagram and importance of phase diagram in field of chemistry and industry.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: GASEOUS STATE

Postulates of kinetic theory of gases and derivation of equation for kinetic molecular theory of gases, deviation from ideal behavior, vander Waals equation of State. PV isotherms of ideal gases, continuity of states, the isotherms of vander Waals equations, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of states. Root mean square, average and most probable velocities. Liquification of gases (based on Joule Thompson effect).

Unit-2	Number of lectures =08	Title of the unit: COLLOIDAL STATE

Dispersion systems, Types and classification of colloidal systems, Preparation and purification of colloidal solutions, Properties of colloidal solutions, Applications of colloids, Emulsions.

Unit-3	Number of lectures = 08	Title of the unit: THERMODYNAMICS – I

Definition of thermodynamic terms : system, surrounding etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work. First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship, Joule-Thomson effect and inversion temperature. Calculation of W, q, dU and dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Unit-4	Number of lectures = 08	Title of the unit: THERMODYNAMICS – II

Standard state, standard enthalpy of formation - Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy.

Unit-5	Number of lectures = 08	Title of the unit: PHASE EQUILIBRIUM

Gibbs phase rule, Statement and meaning of the terms - phase, component and degree of freedom, phase equilibria of one component system - water, and sulphur system.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students would get inside the sound knowledge of gas and their properties and examine the relationships between gas temperature, pressure, amount, and volume.	**3**	**1**	**1**		**2**	**1**	
CO2	Students would able to understand the interfacial phenomena and behaviour of colloidal systems.	**3**	**1**	**2**		**2**	**1**	
CO3	Students would the restate definition of system, surrounding, closed and open system, extensive and intensive properties.	**3**	**1**	**2**		**2**	**1**	
CO4	Students would able to apply First law of thermodynamics and Hess law of heat summation and perceive the concept of Enthalpy.	**3**	**1**	**1**		**3**	**2**	
CO5	Students would able to understand the basic definitions and terms in a phase diagram and importance of phase diagram in field of chemistry and industry.	**3**	**1**	**1**		**3**	**2**	

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.fullonstudy.com/bsc-1st-year-chemistry-notes-pdf
2. https://www.docsity.com/en/bsc-1st-year-notes-chemistry/4194474/
3. https://medium.com/@itsharishjoshi/bsc-1st-year-chemistry-notes-pdf-sem-i-ii-download-here-db8ebb3b5340
4. https://www.youtube.com/watch?v=UVaHSegCPzE

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.

SEMESTER – I

1. Name of the Department: CHEMISTRY						
2. Course Name	**INORGANIC CHEMISTRY – I**			**L**	**T**	**P**
3. Course Code	**CH104**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** To introduce and explain various properties of atomic structure, periodic table and nuclear chemistry: de Broglie matter waves, Heisenberg uncertainty, atomic orbitals, quantum numbers, Aufbau's, Pauli's and Hund's multiplicity rules along with VSEPR (Valence Shell Electron Pair Repulsion) and Molecular Orbital theory.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students are able to evaluate the atomic structure and their properties along with principles, shapes and electronic configurations.
CO2	Understanding of various periodic properties and their variations gives an idea of elemental nature.
CO3	Students are taught principles, types and strengths of various chemical combinations for effective application of bonding.
CO4	Analysis and evaluation of hybridization and geometry of molecular system helpful to identify the structure and their reactivity.
CO5	The study of nuclear chemistry and its application create knowledge about the dating and radiotracer techniques along with nuclear decay, nuclear fission and nuclear fusion.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: ATOMIC STRUCTURE

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, quantum numbers, shapes of s, p, and d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rules. Electronic configurations of the elements.

Unit-2	Number of lectures =08	Title of the unit: PERIODIC PROPERTIES

An introduction to modern periodic table, periodicity in properties of elements: Atomic and ionic radii, ionization energy, electron Affinity, electronegativity, effective nuclear charge, shielding effect.

Unit-3	Number of lectures = 08	Title of the unit: CHEMICAL BONDING – I

Introduction, causes of chemical combination, electronic theory of valency, general characteristics of: electrovalent bond, covalent bond, coordinate bond, metallic bonding and hydrogen bonding.

Unit-4	Number of lectures = 08	Title of the unit: CHEMICAL BONDING – II

Hybridization and shapes of simple molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH3, SF4, ClF3, ICl4- and H2O. Molecular Orbital theory for homonuclear and heteronuclear diatomic molecules, bond length, bond angle and bond energy, resonance.

Unit-5	Number of lectures = 08	Title of the unit: NUCLEAR CHEMISTRY

Natural and artificial radioactivity, binding energy, rate equation for nuclear decay, nuclear fission and nuclear fusion and their applications, group displacement law, isotopes and isobars, applications of radioactivity: radiocarbon dating and radio tracer techniques.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students are able to evaluate the atomic structure and their properties along with principles, shapes and electronic configurations.	**2**	**1**	**-**	**2**	**-**	**-**	**2**
CO2	Understanding of various periodic properties and their variations gives an idea of elemental nature.	**1**	**1**	**-**	**3**	**-**	**1**	**2**
CO3	Students are taught principles, types and strengths of various chemical combinations for effective application of bonding.	**2**	**1**	**-**	**2**	**-**	**-**	**3**
CO4	Analysis and evaluation of hybridization and geometry of molecular system helpful to identify the structure and their reactivity.	**1**	**1**	**-**	**1**	**-**	**-**	**1**
CO5	The study of nuclear chemistry and its application create knowledge about the dating and radiotracer techniques along with nuclear decay, nuclear fission and nuclear fusion.	**2**	**1**	**-**	**1**	**-**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=0ofu2inFF0k
2. https://www.youtube.com/watch?v=MCYRhCA7j1s
3. https://www.wiley.com/en-in/Basic+Inorganic+Chemistry,+3rd+Edition-p-9780471505327

13. Books recommended:

1. Advanced Inorganic Chemistry Vol-I & II, Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan, S. Chand & Co. Ltd.
2. Test book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons
3. Simplified Course in Inorganic Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
4. Concise Inorganic Chemistry, J.D. Lee, Black Well Sciences
5. Selected Topics in Inorganic Chemistry, Wahid U Malik, GD Tuli, RD Madan, S Chand Publication.

SEMESTER – I

1. Name of the Department: CHEMISTRY						
2. Course Name	**ORGANIC CHEMISTRY – I**			**L**	**T**	**P**
3. Course Code	**CH105**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** The main objective of this course is to study the nomenclature of organic compounds, structure and bonding of organic molecules considering inductive effect, hyperconjugation, mesomeric effects, hydrogen bonding etc., and mechanism of various types of organic reactions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Analyze structure and bonding of organic molecules considering various types of effects such as inductive effect, hyperconjugation, mesomeric effects, hydrogen bonding etc.
CO2	Evaluate the different types of organic reactions and their mechanism.
CO3	Understand IUPAC nomenclature of Alkane, Alkenes, Alkynes, functional groups, bifunctional and polyfunctional organic compounds.
CO4	Analyze Isomerism and its types.
CO5	Understand and evaluate the mechanism of Hoffmann elimination, Markownikoff's rule, Saytzeff rule, ozonolysis and epoxidation.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: STRUCTURE AND BONDING OF ORGANIC MOLECULES

Hybridizations: sp3, sp2 and sp hybridization of carbon; Bond lengths, bond angles, bond energy, resonance, hyperconjugation, inductive, electomeric and mesomeric effects, hydrogen bonding.

Unit-2	Number of lectures =08	Title of the unit: ORGANIC REACTIONS, MECHANISMS AND THEIR INTERMEDIATES

Types of organic reactions and mechanism: Addition, Substitution and Elimination reaction. Electrophiles and nucleophiles, Reactive intermediates- carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes.

Unit-3	Number of lectures = 08	Title of the unit: IUPAC NOMENCLATURE

Classification of organic compounds, Functional group, Homologous series, IUPAC nomenclature of organic compounds (alkanes, alkenes, alkynes, cycloalkanes, alkyl halides, alcohols, aldehydes, ketones, acids, amides, amines, esters, anhydrides), bifunctional and polyfunctional organic compounds.

Unit-4	Number of lectures = 08	Title of the unit: STEREOCHEMISTRY

Concept of isomerism, types of isomerism: structural and stereoisomerism, E and Z nomenclature. Geometrical isomerism in alicyclic compounds. Conformational isomerism of n-butane and cyclohexanes, axial and equatorial bonds, Newman, Saw horse and Fischer projections.

Unit-5	Number of lectures = 08	Title of the unit: ALKANES AND ALKENES

Preparation of alkanes by hydrogenation of alkenes/alkynes, Reduction of alkyl halides, Grignard reagent, Wurtz reaction. Chemical properties of alkanes. Mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, Saytzeff rule, Hoffmann elimination, Markownikoff's rule, hydroboration-oxidation, oxymercuration-demecuration, Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO4.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Analyze structure and bonding of organic molecules considering various types of effects such as inductive effect, hyperconjugation, mesomeric effects, hydrogen bonding etc.	**3**	**2**	**1**		**1**		**3**
CO2	Evaluate the different types of organic reactions and their mechanism.	**3**	**2**	**1**		**1**		**3**
CO3	Understand IUPAC nomenclature of Alkane, Alkenes, Alkynes, functional groups, bifunctional and polyfunctional organic compounds.	**3**	**3**	**1**		**1**		**3**
CO4	Analyze Isomerism and its types.	**3**	**2**	**1**		**1**		**3**
CO5	Understand and evaluate the mechanism of Hoffmann elimination, Markownikoff's rule, Saytzeff rule, ozonolysis and epoxidation.	**2**	**2**	**1**		**1**		**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.khanacademy.org/science/organic-chemistry
2. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Smith)/Chapter_06%3A_Understanding_Organic_Reactions
3. https://www.dummies.com/education/science/biology/the-basics-of-organic-chemistry/
4. https://www.toppr.com/guides/chemistry/organic-chemistry/

13. Books recommended:

1. Advanced Organic Chemistry, Bahl & Bahl, S. Chand & Co. Ltd.
2. Organic Chemistry Vol.I & II, I.L. Finar
3. Fundamentals of Organic Chemistry, Nafis Haider, S. Chand & Co. Ltd.
4. A text book of Organic Chemistry, Bahl & Bahl, S. Chand & Co. Ltd.
5. Organic Chemistry Vol.I, II & III, Dr. Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan.

SEMESTER – I

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL CHEMISTRY LAB – I**			**L**	**T**	**P**
3. Course Code	**CH106**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. **COURSE OBJECTIVES:** The purpose of the undergraduate chemistry Lab program at the Integral University is to provide the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of chemistry, and various other industries.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the basic analytical and technical skills and technical skills to work effectively in the various fields of chemistry
CO2	Understand the basic titration methods and technical skills to work in the different fields of chemistry.
CO3	Able to detect presence of elements and functional group in organic compounds.
CO4	Remember to keep records of all performed experiments in the manner which is required in laboratory
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.

10. Syllabus

Exp – 01	Preparation of standard solution related to normality & molarity.
Exp – 02	Preparation of buffer solution, pH measurement.
Exp – 03	Acid - base titration.
Exp – 04	Oxidation-reduction (redox) titrations. a) To determine the strength of oxalic acid. b) To determine the strength of ferrous ammonium sulphate (Mohr's salt) solution by using external indicator.
Exp – 05	To determine the strength of potassium permanganate solution by using sodium thiosulphate solution. Iodometrically.
Exp – 06	To determine the strength of given copper sulphate solution by using sodium thiosulphate solution. Iodometrically.
Exp – 07	Complexometric titrations. a) To estimate the concentration of calcium ions with EDTA. b) To estimate the concentration of magnesium ions with EDTA.
Exp – 08	Detection of element present in the given organic compounds.
Exp – 09	Detection of functional group present in the given organic compounds. a) Carboxylic b) Phenolic c) Alcoholic d) Aldehydic e) Ketonic f) Ester g) Amine h) Amide

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Understand the basic analytical and technical skills and technical skills to work effectively in the various fields of chemistry	**3**	**2**	**1**		**1**		**3**
CO2	Understand the basic titration methods and technical skills to work in the different fields of chemistry.	**3**	**2**	**1**		**1**		**3**
CO3	Able to detect presence of elements and functional group in organic compounds.	**3**	**3**	**1**		**1**		**3**
CO4	Remember to keep records of all performed experiments in the manner which is required in laboratory	**3**	**2**	**1**		**1**		**3**
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.	**2**	**2**	**1**		**1**		**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf
2. http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf
3. https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf
4. https://www.stem.org.uk/resources/collection/3959/practical-chemistry

13. Books recommended:

1. Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, PragatiEdition.
2. Practical Organic Chemistry, A.I.Vogel.
3. Practical Physical Chemistry: B. Viswanathan and P.S.Raghavan.
4. Experimental Inorganic Chemistry –W.G.Palmer.

SEMESTER – II

1. Name of the Department: CHEMISTRY						
2. Course Name	**BASICS OF COMPUTER**			**L**	**T**	**P**
3. Course Code	**CS110**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Study of computer history and components of computer system, understanding of computer peripheral and storage devices, basics of OS and MS office, basic knowledge of computer networking and internetworking devices and fundamental concepts of Internet and web technologies.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Have a strong foundation of knowledge about the structure of computer system.
CO2	Utilize and configure computer peripheral devices, install and operate system and application software.
CO3	Work on MS office(word, power point and excel) and OS.
CO4	Establish a small computer network and utilize resource sharing.
CO5	Design and develop a website with limited features.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: INTRODUCTION TO COMPUTER

Define Computer, Characteristics features of Computer, Hardware and Software of Computer, languages of Computers, Applications, Block Diagram of Computer System, and Computer Generations.

Unit-2	Number of lectures =08	Title of the unit: COMPUTER ORGANIZATION

Essentials of computer operation, Input-Process- Output Basic Organization of Computer System in Detail- I/O Devices and its functions, Memory management, Booting process (BIOS), Memory Management-RAM, ROM etc. Storage devices - Hard disc, Floppy disc, CD-ROM.

Unit-3	Number of lectures = 08	Title of the unit: OPERATING DEVICES AND OPERATING ENVIRONMENT

Features, Advantages and Drawbacks, DOS, WINDOWS & UNIX; Introduction to Data Processing and Flowchart, Operating environment, MS Office in Detail (Word, Excel & Power Point), short cut keys used in Word, Excel & Power Point.

Unit-4	Number of lectures = 08	Title of the unit: COMPUTER NETWORKING

Introduction to networking, Modem, Network topology concepts and types with advantages and drawbacks of each, components of LAN, WAN and MAN, Medium used in Networks.

Unit-5	Number of lectures = 08	Title of the unit: INTERNET AND WEB TECHNOLOGIES

History and concept, Architecture, Application, Hypertext Markup Language, DHTML, WWW, Gopher, FTP, Telnet, Web Browsers, Net Surfing, Search Engines, Email, Digital Signatures, Network, Security, Firewall.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Have a strong foundation of knowledge about the structure of computer system.							**3**
CO2	Utilize and configure computer peripheral devices, install and operate system and application software.				**1**	**2**		**3**
CO3	Work on MS office(word, power point and excel) and OS.					**3**		**3**
CO4	Establish a small computer network and utilize resource sharing.					**3**	**1**	**2**
CO5	Design and develop a website with limited features.					**2**		**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://edu.gcfglobal.org/en/computerbasics/what-is-a-computer/1/
2. http://vfu.bg/en/e-Learning/Computer-Basics--computer_basics2.pdf
3. https://www.toppr.com/guides/computer-aptitude-and-knowledge/basics-of-computers/basic-computer-terminology/
4. https://www.geeksforgeeks.org/basics-of-computer-and-its-operations/

13. Books recommended:

1. Curtin, “Information Technology: Breaking News”, TMH.
2. Raja Raman, V. “Introduction to Computers”.
3. Nelson, “Data Compression”, BPB
4. Bajpai, Kushwaha & Yadav, “Introduction To Computer & C Programming” , New Age
5. Lehngart, “Internet 101”, Addision Wesley.
6. Chanchal Mittal “Foundation of Information Technology” Pragati.
7. Computer Fundamentals- by Sinha. PK and Sinha P. BPB (Publisher)

SEMESTER – II

1. Name of the Department: CHEMISTRY						
2. Course Name	**ENVIRONMENTAL POLLUTION**			**L**	**T**	**P**
3. Course Code	**CH107**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	10+2 with Mathematics	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** The main objective of this course is to study various types of pollutants, their sources, control and their harmful effects on living species and environment.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Evaluate different types of air pollutants, their harmful effects on living and non-living species; Study of Global Warming, Green House Effect and Ozone Layer Depletion. Oxygen, nitrogen and carbon cycle.
CO2	Analyze the various factors of water quality assessment parameters, water pollutants and Waste water treatment processes.
CO3	Understand the soil composition, soil pollutants, their control, National and International Standards.
CO4	Evaluate the various types waste and their toxicity aspects and management.
CO5	Understand the sources of heavy metals and their related toxicity.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: AIR POLLUTANTS

CO, CO2, ozone, CFC; ozone depletion; global warming & NOx; Harmful effects of pollutants on living and non-living species; Oxygen, nitrogen and CO2 cycle, Air quality standard, Bhopal gas tragedy, Chernobyl disaster.

Unit-2	Number of lectures =08	Title of the unit: WATER QUALITY PARAMETERS AND WATER POLLUTION

Water quality parameters; international and national standards; Water quality assessment. Water pollution and its control; water pollutants; toxicity. Water sampling techniques, Preservation.

Unit-3	Number of lectures = 08	Title of the unit: AGRICULTURAL POLLUTANTS

Fertilizers, insecticides, pesticides, plastics, toxic metals, dyes, surfactants and their toxicity; international and national standards; control.

Unit-4	Number of lectures = 08	Title of the unit: INDUSTRIAL WASTE

Industrial waste: toxic aspects, management and disposal. Radioactive, municipal, and biomedical waste – toxicity hazards, management and disposal.

Unit-5	Number of lectures = 08	Title of the unit: CHEMICAL TOXICOLOGY

Toxic chemicals in the Environment, biochemical effects of Mercury and Lead, Carcinogens, Vector-borne disease, water-borne disease, Pollution and Public Health issues.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Evaluate different types of air pollutants, their harmful effects on living and non-living species; Study of Global Warming, Green House Effect and Ozone Layer Depletion. Oxygen, nitrogen and carbon cycle.	**3**	**2**	**3**	**3**	**3**	**3**	**2**
CO2	Analyze the various factors of water quality assessment parameters, water pollutants and Waste water treatment processes.	**3**	**2**	**3**	**3**	**3**	**3**	**2**
CO3	Understand the soil composition, soil pollutants, their control, National and International Standards.	**3**	**2**	**3**	**3**	**3**	**3**	**2**
CO4	Evaluate the various types waste and their toxicity aspects and management.	**3**	**2**	**3**	**3**	**3**	**3**	**2**
CO5	Understand the sources of heavy metals and their related toxicity.	**3**	**2**	**3**	**3**	**2**	**3**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.britannica.com/science/pollution-environment
2. https://www.livescience.com/22728-pollution-facts.html
3. https://www.hindawi.com/journals/jeph/2012/341637/
4. https://www.conserve-energy-future.com/causes-and-effects-of-environmental-pollution.php

13. Books recommended:

1. Environmental Chemistry Manahan, Stanley E, 2004, Taylor & Francis Ltd
2. Basic Concepts of Environmental Chemistry, Desley W. Connell, 1 edition, CRC-Press
3. Environmental Chemistry: A Global Perspective, Gary W. Vanloon Stephen J. Duffy, Oxford Univ Pr (Sd)
4. Introduction To Environmental Chemistry, Reid, Brian J. Blackwell Science Ltd
5. Chemistry of the Environment, Thomas G. Spiro, William M. Stigliani, 2nd Edition, Prentice Hall publication.
6. Environmental Chemistry, Vanloon, Gary W Duffy, Stephen J., Oxford Higher Education publication

SEMESTER – II

1. Name of the Department: CHEMISTRY						
2. Course Name	**PHYSICAL CHEMISTRY – II**			**L**	**T**	**P**
3. Course Code	**CH108**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** The purpose of this undergraduate course is to impart basic and key knowledge of physical chemistry. By using the principal of physics and mathematics to obtain quantitative relations which are very important for higher studies. After successfully completion of course, the student will able explore subject into their respective dimensions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students got insight knowledge of order of reaction and their determination and understand the factors which could affect the rate of reaction.
CO2	Students would develop the concept of entropy; explore the relation how entropy would be varying with respect to P, T & V.
CO3	Students would perceive the sound knowledge of Gibbs free energy and Helmholtz functions; how they would decide the spontaneity of a process.
CO4	Students would able to difference between "completions" for irreversible chemical reactions and for reversible chemical reactions. They got insight sound knowledge of LeChâtelier's Principle, how the equilibrium quantities of reactants and products are shifted by using Clausius-Clapeyron Equation.
CO5	Students evaluate fundamentals of electrochemistry and understand the concept of pH, solubility and its application.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: CHEMICAL KINETICS

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction concentration, temperature, pressure, solvent, light, catalyst concentration dependence of rates, mathematical characteristics of simple chemical reactions- zero, First, second & pseudo order, half-life and mean life. Determination of the order of reaction differential method, method of integration, method of half-life period and isolation method. Arrhenius equation, concept of activation energy. Simple collision theory.

Unit-2	Number of lectures =08	Title of the unit: THERMODYNAMICS – II

Second Law of Thermodynamics : need for the law, different statements of the law. Thermodynamic scale of temperature. Entropy as a state function, entropy as a function of V&T, entropy as a function of P&T, entropy change in physical change, entropy as a criteria of spontaneity and equilibrium, Entropy change in ideal gases.

Unit-3	Number of lectures = 08	Title of the unit: FREE ENERGY

Gibbs free energy (G) and Helmholtz free energy (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T.

Unit-4	Number of lectures = 08	Title of the unit: CHEMICAL EQUILIBRIUM

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chateliers principle. Reaction isotherm and reaction isochor - Clapeyron equation and Clausius -Clapeyron equation, applications.

Unit-5	Number of lectures = 08	Title of the unit: ELECTROCHEMISTRY

Galvanic cells, standard electrode potential, types of electrodes, measurement of pH; Solubility and solubility product and its applications.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students got insight knowledge of order of reaction and their determination and understand the factors which could affect the rate of reaction.	**3**	**1**	**1**		**2**	**1**	
CO2	Students would develop the concept of entropy; explore the relation how entropy would be varying with respect to P, T & V.	**3**	**1**	**2**		**2**	**1**	
CO3	Students would perceive the sound knowledge of Gibbs free energy and Helmholtz functions; how they would decide the spontaneity of a process.	**3**	**1**	**2**		**2**	**1**	
CO4	Students would able to difference between "completions" for irreversible chemical reactions and for reversible chemical reactions. They got insight sound knowledge of LeChâtelier's Principle, how the equilibrium quantities of reactants and products are shifted by using Clausius-Clapeyron Equation.	**3**	**1**	**1**		**3**	**2**	
CO5	Students evaluate fundamentals of electrochemistry and understand the concept of pH, solubility and its application.	**3**	**1**	**1**		**3**	**2**	

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=UVaHSegCPzE
2. https://stuvera.com/bsc-1st-year-chemistry-notes-pdf/
3. http://www.freebookcentre.net/Chemistry/Physical-Chemistry-Books.html
4. https://www.mobt3ath.com/uplode/book/book-60839.pdf
5. https://examupdates.in/b-sc-books/

13. Books recommended:

1. Physical Chemistry, P.WE. Atkins, ELBS
2. Thermodynamics – J. Rajaram and J.C. Kuriacose – Educational Publishers.
3. Chemical Thermodynamics by R.P.Rastogi et al
4. Principles of physical chemistry by Puri Sharma and Pathan
5. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
6. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
7. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
8. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – II

1. Name of the Department: CHEMISTRY						
2. Course Name	**INORGANIC CHEMISTRY – II**			**L**	**T**	**P**
3. Course Code	**CH109**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Interest among students for general Inorganic Chemistry will be inculcated and introduction of periodic table in terms of classification and properties of s, p and d block elements will be made. Introduction coordination chemistry, nomenclature of coordination compounds in order to understand higher inorganic moieties will be done.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	An understanding is developed for the significance of systematic classification of elements in periodic table.
CO2	Evaluation of anomalous behaviour of elements can be with proper reasoning.
CO3	Introduction of coordination chemistry creates higher order thinking ability to deal with complex inorganic moieties.
CO4	How the stability of coordination complexes can be predicted through the application and remembrance of simple rules.
CO5	A keen interest is created in students to pursue inorganic chemistry in higher classes

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: S – BLOCK ELEMENTS (GROUP – 1 AND 2 ELEMENTS)

General introduction, Electronic configuration, Anomalous properties of the first element of each group, diagonal relationship, Trends in the variation of properties (such as ionization potential, atomic and ionic radii etc.)

Unit-2	Number of lectures =08	Title of the unit: P – BLOCK ELEMENTS (GROUP 13 – 17 ELEMENTS)

General introduction, Electronic configuration, Variation of properties, oxidation states, Anomalous properties of first elements of each group. Study of some important compounds (Such as boron hydrides, fluorocarbons silicates and interhalogen compouds). gases.

Unit-3	Number of lectures = 08	Title of the unit: D – BLOCK ELEMENTS

Characteristic properties of d-block elements. Properties of the elements of the first transition series their Binary compounds such as Carbides, Oxides and Sulphides.

Unit-4	Number of lectures = 08	Title of the unit: CHEMISTRY OF NOBLE GASES

Physical & chemical properties noble gases, special properties of helium, Clathrate compounds, Chemistry of Xe (Structure and bonding in Xe compounds such as XeF2, XeF4 and XeF6). equation and Clausius -Clapeyron equation, applications.

Unit-5	Number of lectures = 08	Title of the unit: COORDINATION COMPOUNDS

Double salts, Werner's coordination theory, IUPAC nomenclature of coordination compounds, Discussion of inner and outer orbital complexes.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	An understanding is developed for the significance of systematic classification of elements in periodic table.	**2**		**1**				**2**
CO2	Evaluation of anomalous behaviour of elements can be with proper reasoning.	**2**						
CO3	Introduction of coordination chemistry creates higher order thinking ability to deal with complex inorganic moieties.	**3**			**1**			
CO4	How the stability of coordination complexes can be predicted through the application and remembrance of simple rules.	**3**						
CO5	A keen interest is created in students to pursue inorganic chemistry in higher classes	**2**		**1**			**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.wiley.com/en-in/Basic+Inorganic+Chemistry,+3rd+Edition-p-9780471505327
2. http://www.t.soka.ac.jp/chem/iwanami/inorg/INO_0001.PDF.
3. https://pubs.acs.org/doi/pdf/10.1021/ed073pA14.2

13. Books recommended:

1. Advanced Inorganic Chemistry Vol-I & II, Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan, S. Chand & Co. Ltd.
2. Test book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons
3. Simplified Course in Inorganic Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
4. Concise Inorganic Chemistry, J.D. Lee, Black Well Sciences.

SEMESTER – II

1. Name of the Department: CHEMISTRY						
2. Course Name	**ORGANIC CHEMISTRY – II**			**L**	**T**	**P**
3. Course Code	**CH110**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Students will be able to understand the about arenes and Aromaticity, Huckel rule of aromaticity, Aromatic electrophilic substitution reactions, Alkyl and Aryl Halides, Mechanism of nucleophilic substitution reaction of alkyl halides SN1 and SN2 reactions, Acidic nature, Reactions of alcohols,dihydric alcohols,trihydric alcoholsaldehydes and ketones, chemical reactions of aldehydes and ketones.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understanding of Kekule structure, Stability and carbon-carbon bond lengths, resonance, Huckel rule of aromaticity, chemical reaction and mechanism of Aromatic electrophilic substitution.
CO2	Comprehension of the classification, methods of formation and chemical reactions of alkyl halides, Mechanism of nucleophilic substitution reaction of alkyl halides (SN1 and SN2 reactions) with energy profile diagrams.
CO3	To create basic knowledge of nomenclature, methods of formation, reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature, Reactions of alcohols, Dihydric alcohols, chemical reactions of vicinal glycols and pinacol-pinacolone rearrangement.
CO4	Able to evaluate different types Synthesis of aliphatic aldehydes and ketones, alcohols, carboxylic acids and named reactions as Reimer-Tiemann reaction, gattermann-koch reaction and aromatic ketones by Friedel craft acylation.
CO5	Analyze and compare the mechanism of nucleophilic additions to carbonyl groups with aldol condensation, Cannizzaro reaction, Baeyer-Villiger oxidation, Meerwine Pondorof Verlay reduction, Clemmensen reduction and Wolff-Kishner reduction.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: ARENES AND AROMATICS

Nomenclature of benzene derivatives. Kekule structure of benzene, Stability and carbon-carbon bond lengths of benzene, resonance, Huckel rule of aromaticity, Aromatic electrophilic substitution general pattern of the mechanism, Mechanism of nitration, halogenation. Sulphonation and Friedel-Crafts reaction.

Unit-2	Number of lectures =08	Title of the unit: ALKYL AND ARYL HALIDES

Nomenclature, classification, methods of formation and chemical reactions of alkyl halides. Mechanims of nucleophilic substitution reaction of alkyl halides (SN1 and SN2 reactions) with energy profile diagrams.

Unit-3	Number of lectures = 08	Title of the unit: ALCOHOLS

Monohydric alcohols- nomenclature, methods of formation, reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature, Reactions of alcohols. Dihydric alcohols - nomenclature, methods of formation, chemical reactions of vicinal glycols and pinacol-pinacolone rearrangement. Trihydric alcohols – nomenclature, methods of formation and chemical reactions of glycerol.

Unit-4	Number of lectures = 08	Title of the unit: ALDEHYDES AND KETONES

Synthesis of aliphatic aldehydes and ketones with particular reference to acid chlorides, alcohols, carboxylic acids, Grignard reagent, alkenes and 1,3-dithianes. Synthesis of aromatic aldehydes by oxidation of alkyl benzene, Reimer-Tiemann reaction, gattermann-koch reaction and aromatic ketones by Friedal craft acylation.

Unit-5	Number of lectures = 08	Title of the unit: CHEMICAL REACTION OF ALDEHYDES AND KETONES

Mechanism of nucleophilic additions to carbonyl group with particular reference: aldol condensation, Cannizzaro reaction. Perkin reaction, Wittig reaction, Mannich reaction. Baeyer-Villiger oxidation, Meerwine Pondorof Verlay reduction, Clemmensen reduction and Wolff-Kishner reduction.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Understanding of Kekule structure, Stability and carbon-carbon bond lengths, resonance, Huckel rule of aromaticity, chemical reaction and mechanism of Aromatic electrophilic substitution.	**3**	**1**	**1**		**2**		**2**
CO2	Comprehension of the classification, methods of formation and chemical reactions of alkyl halides, Mechanism of nucleophilic substitution reaction of alkyl halides (SN1 and SN2 reactions) with energy profile diagrams.	**3**	**1**	**1**		**2**		**2**
CO3	To create basic knowledge of nomenclature, methods of formation, reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature, Reactions of alcohols, Dihydric alcohols, chemical reactions of vicinal glycols and pinacol-pinacolone rearrangement.	**3**	**1**	**1**		**2**		**2**
CO4	Able to evaluate different types Synthesis of aliphatic aldehydes and ketones, alcohols, carboxylic acids and named reactions as Reimer-Tiemann reaction, gattermann-koch reaction and aromatic ketones by Friedel craft acylation.	**3**	**1**	**1**		**2**		**2**
CO5	Analyze and compare the mechanism of nucleophilic additions to carbonyl groups with aldol condensation, Cannizzaro reaction, Baeyer-Villiger oxidation, Meerwine Pondorof Verlay reduction, Clemmensen reduction and Wolff-Kishner reduction.	**3**	**1**	**1**		**2**		**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Smith)/Chapter_06%3A_Understanding_Organic_Reactions
2. https://www.dummies.com/education/science/biology/the-basics-of-organic-chemistry/
3. https://www.toppr.com/guides/chemistry/organic-chemistry/

13. Books recommended:

1. Advanced Organic Chemistry, Bahl & Bahl, S. Chand & Co. Ltd.
2. Organic Chemistry Vol.I & II, I.L. Finar
3. Fundamentals of Organic Chemistry, Nafis Haider, S. Chand & Co. Ltd.
4. Organic Chemistry Vol.I, II & III, Dr. Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan

SEMESTER – II

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL CHEMISTRY LAB – II**			**L**	**T**	**P**
3. Course Code	**CH111**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. **COURSE OBJECTIVES:** Student will be able to work effectively and safely in a laboratory environment, practical/technical/ communication skills, concepts to solve qualitative and quantitative problems,transferable skills like ability to work in teams as well as independently.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.
CO2	Able to Evaluate water quality parameters like chloride content and alkalinity.
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.
CO4	Know about the principles of qualitative and quantitative analysis of inorganic mixtures.
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.

10. Syllabus

Exp – 01	To determine chloride content in the given water sample.
Exp – 02	To determine the percentage of available chlorine in the given bleaching powder sample.
Exp – 03	To determine Alkalinity in the given water sample.
Exp – 04	Qualitative analysis of inorganic mixture Cations: $NH4^+$ Pb^{2+}, Ag+, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+
Exp – 05	Qualitative analysis of inorganic mixture Anions: CO^{32-}, S^{2-}, SO_3^{2-}, SO_4^{2-}, NO_3^- ,NO_2^- , CH_3COO^-, F^- , Cl^-, Br^-, I^-, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$,

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.	**3**	**1**	**1**		**2**	**1**	**2**
CO2	Able to Evaluate water quality parameters like chloride content and alkalinity.	**3**	**1**	**1**		**1**	**2**	**2**
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.	**3**	**1**	**1**		**1**		**2**
CO4	Know about the principles of qualitative and quantitative analysis of inorganic mixtures.	**3**	**1**	**1**		**1**		**2**
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.	**3**	**1**	**1**		**1**	**2**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf
2. http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf
3. https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf
4. https://www.stem.org.uk/resources/collection/3959/practical-chemistry
5. http://pioneer.netserv.chula.ac.th/~sanongn1/processing.pdf

13. Books recommended:

1. Advanced Organic Chemistry, Bahl & Bahl, S. Chand & Co. Ltd.
2. Organic Chemistry Vol.I & II, I.L. Finar
3. Practical Physical Chemistry: B. Viswanathan and P.S.Raghavan.
4. Experimental Inorganic Chemistry –W.G.Palmer.
5. Organic Chemistry Vol.I, II & III, Dr. Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan.

SEMESTER – III

1. Name of the Department: CHEMISTRY						
2. Course Name	INDUSTRIAL ASPECTS OF PHYSICAL CHEMISTRY			L	T	P
3. Course Code	CH201			3	1	0
4. Type of Course (use tick mark)				Core (√)	DE ( )	FC ( )
5. Pre-requisite (if any)	10+2 with Chemistry	6. Frequency (use tick marks)	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		Tutorials = 10		Practical = Nil		

8. **COURSE OBJECTIVES:** The purpose of this course is to study the use of simple models for predictive understanding of physical phenomena associated to chemical thermodynamics and adsorption and absorption kinetics and to develop deep understanding of theory for degradation and corrosion of materials in various environments and to present existing protection strategies for prevention of corrosion in different contexts with kinetics.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will gain an understanding of the thermodynamic and kinetic forces involved in chemical reactions which determine how much and how soon products are formed.
CO2	Students will be able to evaluate the chemical kinetics, how reaction rates are measured and represented in rate laws, and applications of chemical kinetics in studying enzyme mechanisms.
CO3	Students will gain an understanding of methods for determining molecular mass based upon colligative properties.
CO4	Students will create the own understanding approaches to the finding of unknown composition of analyte from critical solute temperature graph.
CO5	Students will gain an understanding of approaches to the development of dry & wet corrosion and its prevention.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: ADSORPTION

Physisorption and Chemisorptions, Applications of adsorption, Adsorption of gases by solids, Freundlich adsorption isotherm, Langmuir's theory of adsorption, BET theory of multilayer adsorption, Determination of surface area, Adsorption isotherms.

Unit-2	Number of lectures =08	Title of the unit: CATALYSIS

General characteristics of catalytic reactions Acid-base catalysis, Enzyme catalysis, Mechanism and kinetics of enzyme catalyzed reactions, Michaelis-Menten equation, Effect of temperature on enzyme catalysis, Heterogeneous catalysis, Surface reactions, Kinetics of surface reactions.

Unit-3	Number of lectures = 08	Title of the unit: COLLIGATIVE PROPERTIES

Lowering of vapour pressure, Raoult's law, Determination of molecular mass of solute from lowering of vapour pressure, Elevation of boiling point, Relation between elevation of boiling point and lowering of vapour pressure, Determination of molecular mass of solute from elevation of boiling point, Depression of freezing point, Relation between depression of freezing point and lowering of vapour pressure, Determination of molecular mass of solute from depression of freezing point, Osmosis and osmotic pressure, van't Hoff's equation.

Unit-4	Number of lectures = 08	Title of the unit: AZEOTROPIC MIXTURES

Distillation of immiscible liquids, Solubility of partially miscible liquids, Phenol water system, CST and effect of impurities on CST.

Unit-5	Number of lectures = 08	Title of the unit: CORROSION AND ITS CONTROL

Introduction, Economic aspects of corrosion, Dry or Chemical Corrosion, Wet or electrochemical corrosion, Mechanism of Electrochemical Corrosion, Prevention from corrosion.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will gain an understanding of the thermodynamic and kinetic forces involved in chemical reactions which determine how much and how soon products are formed.	3	1	1		2	1	
CO2	Students will be able to evaluate the chemical kinetics, how reaction rates are measured and represented in rate laws, and applications of chemical kinetics in studying enzyme mechanisms.	3	1	2		3	1	
CO3	Students will gain an understanding of methods for determining molecular mass based upon colligative properties.	3	1	2		3	1	
CO4	Students will create the own understanding approaches to the finding of unknown composition of analyte from critical solute temperature graph.	3	1	1		2	1	
CO5	Students will gain an understanding of approaches to the development of dry & wet corrosion and its prevention.	3	1	1		2	1	

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. http://nsdl.niscair.res.in/jspui/handle/123456789/351
2. https://pubs.acs.org/doi/full/10.1021/ie50157a002
3. https://www.omicsonline.org/industrial-chemistry.php
4. http://nsdl.niscair.res.in/jspui/handle/123456789/351?mode=full

13. Books recommended:

1. Admson, A.W., Physical Chemistry of Surfaces, 4th edition, Pubs: John Wiely & Sons, New York, 1982.
2. Austin H. T., Shreve's Chemical Process Industries, Pubs: McGraw Hill Book Company, New York(1984).
3. Kent James A. (ed.), Reigel's Handbook of Industrial Chemistry, Pubs: Van Nostrand inhold Company, London (1983).
4. Pandey C.N., Text Book of Chemical Technology, Vol. I & II, Pubs: Vikas Publishing House, Pvt. Ltd., New Delhi (1999).
5. Buchner V., Sohliebs P., Winter G. & Buchel K.H., Industrial Inorganic Chemistry, Pubs: V. Ch. Publishers, New York (1989).

SEMESTER – III

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL ASPECTS OF INORGANIC CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH202**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** To acquaint the students with basic metallurgical processes and their applications in industries along with an overview of alloys, their applications and extraction of important metals from their ores.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Basic understanding of important aspects of inorganic chemistry application such as metallurgical processes is created among students.
CO2	How inorganic materials are important for industrial chemistry is evaluated through suitable examples.
CO3	Evaluation of Commercial preparations of alloys, their merits and demerits and how they can be applied in industrial chemistry is done.
CO4	Importance and application of metallurgical processes in industrial chemistry is learnt.
CO5	Important applications of inorganic materials like zeolites, alumina etc. are evaluated by their reactions and properties.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: METALLURGY**
Basic metallurgical operations- crushing and pulverization, concentration, calcinations, roasting, types of roasting, reduction and refining.		
Unit-2	**Number of lectures =08**	**Title of the unit: PHYSICO CHEMICAL PRINCIPLES OF EXTRACTION**
Methods of extraction and refining of Copper, lead, aluminium and Zinc from their ores.		
Unit-3	**Number of lectures = 08**	**Title of the unit: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**
Availability, forms, structure and modification. Alumina, silica, silicates, zeolites.		
Unit-4	**Number of lectures = 08**	**Title of the unit: METALS AND ALLOYS**
Important metals and alloys, iron, copper, aluminium, lead, nickel, titanium and their alloys, mechanical and chemical properties and their applications.		
Unit-5	**Number of lectures = 08**	**Title of the unit: ADHESIVE**
Introduction, Classification of adhesives, adhesives action, development of adhesive strength, chemical factors influencing adhesive action. from corrosion.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Basic understanding of important aspects of inorganic chemistry application such as metallurgical processes is created among students.	**2**		**1**		**1**	**1**	**2**
CO2	How inorganic materials are important for industrial chemistry is evaluated through suitable examples.	**2**	**1**				**1**	**2**
CO3	Evaluation of Commercial preparations of alloys, their merits and demerits and how they can be applied in industrial chemistry is done.	**1**						**1**
CO4	Importance and application of metallurgical processes in industrial chemistry is learnt.	**2**	**1**	**1**		**1**	**1**	**2**
CO5	Important applications of inorganic materials like zeolites, alumina etc. are evaluated by their reactions and properties.	**2**					**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.degruyter.com/view/title/304228
2. https://books.google.com/books/about/Industrial_inorganic_chemistry.html?id=y43xAAAAMAAJ
3. https://oer.avu.org/bitstream/handle/123456789/743/CHE%2012_EN%20Inorganic%20Chemistry.pdf?sequence=1&isAllowed=y
4. https://organic-chemistry.chemistryconferences.org/events-list/industrial-inorganic-chemistry

13. Books recommended:

1. Austin H. T., Shreve's Chemical Process Industries, Pubs: McGraw Hill Book Company, New York (1984).
2. Kent James A. (ed.), Reigel's Handbook of Industrial Chemistry, Pubs: Van Nostrand Hold Company, London (1983).
3. Pandey C.N., Text Book of Chemical Technology, Vol. I & II Pubs: Vikas Publishing House, Pvt. Ltd., New Delhi (1999).
4. Buchner V., Sohliebs P., Winter G. & Buchel K.H., Industrial Inorganic Chemistry, Pubs: V. Ch. Publishers, New York (1989).
5. Fumer I.E. and Zaitsev V.N., General Chemical Engineering, Pubs: Mir Publishers, Moscow (1961).
6. Badger W.L. and Bancher J.T., Introduction to Chemical Engineering, Pubs: McGraw-Hill Co., U.S.A, 1986.
7. McCabe W.L. and Smith J.C., Unit Operations in Chemical Engineering, Pubs: McGraw-Hill Book Company, New York, 1984. 8. Perry J.H., Chemical Engineering Handbook, Pubs: McGraw-Hill Book Company, New York, 1993.

SEMESTER – III

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL ASPECTS OF ORGANIC CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH203**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** To study the various properties and role of organometallic reagents in the synthesis of organic compounds such as Grignard reagents, organo-lithium, Zinc, Copper, Palladium, Nickel compounds, Lithium aluminum hydride, Sodium borohydride, Alkoxides, Boron aluminum hydride, Organo-silicon, Organo-palladium and Lithium organo-cuprates compounds. Also introduce the carbon nanotubes: synthesis, structure, characterization, mechanism, modification and applications.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	The study of various techniques used in the organic synthesis gives additional strength and understanding regarding bio-transformations, enzyme-catalyzed and microwave-induced reactions.
CO2	To create the capability of the synthesis and applications of different organometallic reagents such as Grignard reagents, Organo-lithium, Zinc, Copper, Palladium and Nickel compounds along with homogeneous catalytic reactions, hydrogenation and hydroformylation.
CO3	Students can analyze the synthesis and applications of organo-silicon, Organo-palladium and lithium organo-cuprates compounds.
CO4	Evaluation and analysis of various chemical reactions: reduction with Lithium aluminum hydride, Sodium borohydride, Alkoxides, Boron aluminum hydride creates a new dimension in the study. Dissolving metal reductions and non-metallic reducing reactions also an additional benefit.
CO5	Synthesis, structure, characterization, mechanism, modification and applications carbon nanotubes give additional support to the students to understand the carbon nanotubes.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: TECHNIQUES IN ORGANIC SYNTHESIS

Bio-tranformatons – Enzyme catalysed reactions, Microwave induced reactions-Principle, conditions, advantages over conventional heating methods- Applications, sonication.

Unit-2	Number of lectures =08	Title of the unit: ORGANOMETALLIC REAGENTS

Synthesis and applications of Grignard reagents-organolithium, Zinc, Copper, Palladium, Nickel compounds in organic synthesis- Homogeneous catalytic reactionshydrogenation, hydroformylation.

Unit-3	Number of lectures = 08	Title of the unit: METHODS IN ORGANIC SYNTHESIS – I

Organosilicon Compounds: Preparation and applications in organic synthesis; Applications of Pd (0) and Pd (II) complexes in organic synthesis- Suzuki and Sonogashira coupling, Heck reaction, Preparation and applications of lithium organocuparates.

Unit-4	Number of lectures = 08	Title of the unit: METHODS IN ORGANIC SYNTHESIS – II

Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bismethoxyethoxyaluminium hydride, boron aluminium hydride and derivatives-catalytic metal hydrogenation-dissolving metal reductions, Non-metallic reducing agents including enzymatic and microbial reductions.

Unit-5	Number of lectures = 08	Title of the unit: CARBON NANOTUBES

Synthesis, Single walled carbon nanotubes, Structure and characterization, Mechanism of formation, chemically modified carbon nanotubes, Doping, Functionalizing nanotubes, Applications of carbon nanotubes.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	The study of various techniques used in the organic synthesis gives additional strength and understanding regarding bio-transformations, enzyme-catalyzed and microwave-induced reactions.	**1**	**1**	**1**	**1**	**-**	**1**	**3**
CO2	To create the capability of the synthesis and applications of different organometallic reagents such as Grignard reagents, Organo-lithium, Zinc, Copper, Palladium and Nickel compounds along with homogeneous catalytic reactions, hydrogenation and hydroformylation.	**2**	**1**	**2**	**1**	**-**	**1**	**2**
CO3	Students can analyze the synthesis and applications of organo-silicon, Organo-palladium and lithium organo-cuprates compounds.	**2**	**1**	**2**	**1**	**-**	**1**	**1**
CO4	Evaluation and analysis of various chemical reactions: reduction with Lithium aluminum hydride, Sodium borohydride, Alkoxides, Boron aluminum hydride creates a new dimension in the study. Dissolving metal reductions and non-metallic reducing reactions also an additional benefit.	**1**	**1**	**2**	**1**	**-**	**1**	**2**
CO5	Synthesis, structure, characterization, mechanism, modification and applications carbon nanotubes give additional support to the students to understand the carbon nanotubes.	**1**	**1**	**2**	**2**	**-**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.chem.ubc.ca/chemistry-412-industrial-organic-chemistry
2. https://www.britannica.com/technology/chemical-industry/Organic-chemicals.
3. http://www.uab.cat/guiesdocents/2019-20/g102495a2019-20iENG.pdf

13. Books recommended:

1. McCabe W.L. and Smith J.C., Unit Operations in Chemical Engineering, Pubs:McGraw-Hill Book Company, New York,1984.
2. Perry J.H., Chemical Engineering Handbook, Pubs: McGraw-Hill Book Company, NewYork, 1993.
3. Rao, C. N. R, Muller,A and Cheetam, A.K. (Eds) (2004): The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH, Weinheim.
4. Poole,C. P and Owens,Jr: F. J (2003): Introduction to Nanotechnology Wiley Interscience, New Jersey.
5. Kenneth J. Klabunde (Ed) (2001), Nanoscale materials in Chemistry, WileyInterscience, New York.
6. Cary, F. A and Sundberg,R. I. (2009) :Advanced Organic Chemistry, Part A and B, 5th Edition, Springer.
7. Smith,M. B. (2005): Organic Synthesis, 2nd Edition, McGraw-Hill: New York.
8. Bansal R K(1999): Heterocyclic Chemistry, New Age International
9. Acheson R H, (1976): An introduction to the chemistry of Heterocyclic compounds, Wiley

SEMESTER – III

1. Name of the Department: CHEMISTRY						
2. Course Name	MATERIALS AND ENERGY BALANCE			L	T	P
3. Course Code	CH204			3	1	0
4. Type of Course (use tick mark)				Core (√)	DE ( )	FC ( )
5. Pre-requisite (if any)	10+2 with Chemistry	6. Frequency (use tick marks)	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		Tutorials = 10		Practical = Nil		

8. **COURSE OBJECTIVES:** The purpose of this course is to study the basic concepts of mole, significant figures, solution chemistry and understanding the principles of solving problems on molarity, normality mole fraction concept etc. Thereafter apply the materials balance & energy balance concept and its calculations to chemical industries unit operations.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will be able to analyze the mathematical interdisciplinary numerical problem and chemical reactions and strategies to balance them.
CO2	Students will be able to evaluate the solution chemistry numerical for titrimetric analysis.
CO3	Students will have a firm foundation in the fundamentals and application of Choice of system and basis of molecular processes with chemical reactions.
CO4	Students will have a firm foundation in the fundamentals & applications materials and energy balance for the particular reaction and its scheme.
CO5	Students will be able to clearly communicate the results of scientific work in chemical engineering operations such as distillation, evaporation, absorption and crystallization.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: UNITS AND DIMENSIONS

Introduction, Dimensions & Systems of Units, Fundamental quantities, Derived Quantities, Conversions & Problems.

Unit-2	Number of lectures =08	Title of the unit: BASIC CHEMICAL CALCULATION

Introduction, Concept of atom, Mole and mole fraction, Methods of expressing the composition of mixtures (mass percent, volume percent, mole percent), equivalent weight, normality, molarity, molality.

Unit-3	Number of lectures = 08	Title of the unit: MATERIAL BALANCE

Process classification, Choice of system and basis of molecular processes with chemical reactions, Material balance calculations, multiple unit processes, Recycle and bypass.

Unit-4	Number of lectures = 08	Title of the unit: ENERGY BALANCE

Energy balance: Forms of energy, Energy balance, Energy changes in physical processes, Energy changes in reactions, Energy balance Calculations.

Unit-5	Number of lectures = 08	Title of the unit: MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS

Material Balance without chemical reactions: Flow diagram for material balance, simple material balance without recycles or bypass for chemical engineering operations such as distillation, evaporation, absorption and crystallization.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will be able to analyze the mathematical interdisciplinary numerical problem and chemical reactions and strategies to balance them.	3	1	1		2	1	
CO2	Students will be able to evaluate the solution chemistry numerical for titrimetric analysis.	3	1	2		2	1	
CO3	Students will have a firm foundation in the fundamentals and application of Choice of system and basis of molecular processes with chemical reactions.	3	1	2		2	1	
CO4	Students will have a firm foundation in the fundamentals & applications materials and energy balance for the particular reaction and its scheme.	3	1	1		3	2	
CO5	Students will be able to clearly communicate the results of scientific work in chemical engineering operations such as distillation, evaporation, absorption and crystallization.	3	1	1		3	2	

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118237786
2. https://beeindia.gov.in/sites/default/files/1Ch4.pdf
3. https://www.sanfoundry.com/best-reference-books-material-energy-balance-calculations/
4. https://books.google.com/books/about/Handbook_on_Material_and_Energy_Balance.html?id=9l3o1K2B26QC

13. Books recommended:

1. B.I. and Vora S.M., Stoichiometry, 3rd edition, Pubs: Tata McGraw-Hill Publishing Company Ltd. New Delhi, 1984.
2. Badger W.L. and Bancher J.T., Introduction to Chemical Engineering, Pubs: McGraw-Hill Co., U.S.A, 1986.
3. McCabe W.L.and Smith J.C., Unit Operations in Chemical Engineering, Pubs: McGraw-Hill Book Company, New York, 1984.
4. Perry J.H., Chemical Engineering Handbook, Pubs: McGraw-Hill Book Company, New York, 1993.
5. Himmelbkeause D.M., Basic principles and catenations of chemical Engineering, 6th edition, Pubs: Prentic Hall, 2003.
6. Forst A.S., Wenzel L.A., Clump C.W., Maus L., Andersen L.B., Principles of unit operations, 2nd edition, Pubs: John Wiley and Sons, 1994.
7. Chattopadhay P., Unit Operations of Chemicals Engineering, Vol I, Pubs: Khanna Publishers, Delhi, 1996.

SEMESTER – III

1. Name of the Department: CHEMISTRY						
2. Course Name	INDUSTRIAL ASPECTS OF MICROBIOLOGY			L	T	P
3. Course Code	CH205			3	1	0
4. Type of Course (use tick mark)				Core ( )	DE (√)	FC ( )
5. Pre-requisite (if any)	10+2 with Chemistry	6. Frequency (use tick marks)	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		Tutorials = 10		Practical = Nil		

8. **COURSE OBJECTIVES:** The main objective of this course is to study the classification and nomenclature of microorganisms, culturing and preservation of microbes, basic concept of fermentation, industrial contamination problems and production mechanism of industrial metabolites.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will be able to understand the concept of microorganism classification and nomenclature, general characteristics and importance of Viruses, Bacteria, Actinomycetes, algae and fungi and their applications in fermentation industry
CO2	Students will be able to grasp the concept Growth kinetics of microbes culturing and their preservation techniques as well as factors affecting the growth
CO3	Students will be introduced to fermentation: which includes general structure of a fermenter and its types. Build the firm foundation of USP & DSP and its purification methods
CO4	Evaluate mechanisms and process for the industrial production of metabolites such as Antibiotics, Enzymes, Solvents, Vitamins and Organic Acids.
CO5	Introduction to the concept of industrial contamination problems: microbiological examination of contaminants and their control through sterilization techniques.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: CLASSIFICATION AND NOMENCLATURE OF MICROORGANISMS

Concept of kingdom-protista, prokaryotes and eukaryotes, Introduction to Microbial Diversity: General characteristics and importance of Viruses, Bacteria, Actinomycetes, algae and fungi. Use of microorganisms in fermentation industry.

Unit-2	Number of lectures =08	Title of the unit: PURE CULTURE AND PRESERVATION OF MICROBES

Growth phases – kinetics, asynchronous, synchronous, batch and continuous culture. Factors affecting growth. Bacterial Nutrition & Fermentation media: Components, Natural and synthetic media. Microbiological Assay: Bioassay of growth supporting substances- Amino acids and Vitamins.

Unit-3	Number of lectures = 08	Title of the unit: BASIC CONCEPTS OF FERMENTATION

Types of fermentation. General Structure of a Fermenter. Introduction to upstream and downstream processing. Unit operations in Downstream processing (DSP): Disintegration of cells, Separation, Extraction, Concentration and purification of products.

Unit-4	Number of lectures = 08	Title of the unit: INDUSTRIAL PRODUCTION

Production of antibiotics- Penicillin and semi-synthetic penicillins. Production of enzymes-Amylase. Immobilization of enzymes and applications of immobilized enzymes. Production of solvent- Ethanol. Production of Vitamins- Cyanocobalamin. Production of Organic Acids- Acetic Acid. Production of Amino Acids- Glutamic Acid.

Unit-5	Number of lectures = 08	Title of the unit: CONTAMINATION PROBLEM IN FERMENTATION

Microbiological examination of water and common contaminant. Food poisoning. Control of microorganisms, Sterilization, inhibiting substances- Antibiotics, Minimum inhibitory concentration.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will be able to understand the concept of microorganism classification and nomenclature, general characteristics and importance of Viruses, Bacteria, Actinomycetes, algae and fungi and their applications in fermentation industry	3	2	1		1		2
CO2	Students will be able to grasp the concept Growth kinetics of microbes culturing and their preservation techniques as well as factors affecting the growth	3	2	1		1		1
CO3	Students will be introduced to fermentation: which includes general structure of a fermenter and its types. Build the firm foundation of USP & DSP and its purification methods	3	3	1		1		2
CO4	Evaluate mechanisms and process for the industrial production of metabolites such as Antibiotics, Enzymes, Solvents, Vitamins and Organic Acids.	3	2	1		1		1
CO5	Introduction to the concept of industrial contamination problems: microbiological examination of contaminants and their control through sterilization techniques.	2	2	2		1		1

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=V0BzQQCCwgo
2. https://www.youtube.com/watch?v=lm76h4h1R6k
3. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/17%3A_Industrial_Microbiology
4. https://courses.lumenlearning.com/boundless-microbiology/chapter/industrial-microbiology/

13. Books recommended:

1. Medical Microbiology, Vol. 1: Microbial Infection, Vol. 2 : Practical Medical Microbiology, Authors- Mackie and McCartney.
2. Epidemiology and Infections, Author- Smith
3. Microbiology in Clinical Practice, Author- D.C. Shanson.
4. Diagnostic Microbiology, Authors- Baron, Peterson and Finegold.
5. Textbook of Industrial Microbiology, Author- A. H. Patel.
6. Industrial Microbiology, Author- L. E. Cassida
7. Industrial Microbiology, Author- G. Reed.

SEMESTER – III

1. Name of the Department: CHEMISTRY						
2. Course Name	**BIOCHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH206**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Understand the concept of Biochemistry regarding BiomoleculesCarbohydrates, proteins, lipids, Nucleic acids, Enzymes.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	The students will able to explain about the chemical structures of carbohydrate, and their classification and uses.
CO2	Student will able to know about amino acids and primary, secondary, tertiary, quaternary structure of proteins
CO3	The student will able to know about enzymes and their characteristics. They also will be able to know the importance of enzymes in chemical industries.
CO4	The students will explain the structure and function of lipids, circulating lipids and inflammatory lipid mediators etc..
CO5	The students will understand about the structure and function of nucleosides and nucleotides.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: CARBOHYDRATES

Introduction and classification, monosaccharide (glucose and fructose) physical and chemical properties and their uses. Disaccharides (Sucrose), Physical and chemical properties and their uses. Polysaccharides (Starch and Cellulose); Physical and Chemical Properties and their uses.

Unit-2	Number of lectures =08	Title of the unit: AMINO ACIDS, PPTIDES AND PROPTIENS

Introduction, Classification, and Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitter ion and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Unit-3	Number of lectures = 08	Title of the unit: ENZYMES

Introduction and Characteristic features of enzymes. Factors influencing enzyme activity, Coenzymes, prosthetic group, Lock and key hypothesis, induced fit hypothesis. Introduction to Biocatalysis: Importance in "Chemical Industry.

Unit-4	Number of lectures = 08	Title of the unit: LIPIDS

Introduction, Classification, Triglycerides, Fatty acids, Hydrogenation of Triglycerides, Saponification of Triglycerides, Reaction of carboxyl groups of fatty acids, Structure and Biological importance of Prostaglandins.

Unit-5	Number of lectures = 08	Title of the unit: NUCLEIC ACID

Introduction, Nucleosides and nucleotides; Heterocyclic aromatic amine bases, monosaccharides (D-ribose or 2-deoxy-D-ribose) and phosphate ions, Structure of primary and secondary (double helix model) of DNA.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	The students will able to explain about the chemical structures of carbohydrate, and their classification and uses.	**2**	**2**	**1**	**1**	**2**	**1**	**1**
CO2	Student will able to know about amino acids and primary, secondary, tertiary, quaternary structure of proteins	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO3	The student will able to know about enzymes and their characteristics. They also will be able to know the importance of enzymes in chemical industries.	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO4	The students will explain the structure and function of lipids, circulating lipids and inflammatory lipid mediators etc..	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO5	The students will understand about the structure and function of nucleosides and nucleotides.	**2**	**2**	**1**	**1**	**1**	**1**	**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=uM1t0mWXU30
2. https://www.youtube.com/watch?v=dKT_9AjO9BE
3. https://www.youtube.com/watch?v=Q6R4o-oECxs
4. https://www.youtube.com/watch?v=ymYZg-klKR8
5. https://www.youtube.com/watch?v=FoswKE7tUH8

13. Books recommended:

1. Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd, and Saibal Kanti Bhattacharjee, Seventh edition, Pearson publication.
2. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren, Second edition, Oxford Publication.
3. Organic Chemistry by T.W.Graham Solomons, and Craig B. Fryhle, Ninth edition, Wiley Publication.
4. Organic Chemistry by IL Finar, Volume 1 & 2, Sixth edition, Pearson Publication.
5. J.M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry, 6th Edn. W.H. Freeman and Co. (2006).
6. D.L. Nelson, M.M. Cox, and A.L. Lehninger, Principles of Biochemistry. IV Edition. W.H. Freeman and Co. (2009).
7. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, Harper's
8. Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill (2009).

SEMESTER – III

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL CHEMISTRY LAB – III**			**L**	**T**	**P**
3. Course Code	**CH207**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. **COURSE OBJECTIVES:** Student will be able to work effectively and safely in a laboratory environment, practical/technical/ communication skills, concepts to solve qualitative and quantitative problems,transferable skills like ability to work in teams as well as independently.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.
CO2	Able to Evaluate water quality parameters like chloride content and alkalinity.
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.
CO4	Know about the principles of qualitative and quantitative analysis of inorganic mixtures.
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.

10. Syllabus

Exp – 01	Determine the density or specific gravity of an unknown liquid.
Exp – 02	To determine the water equivalent of calorimeter.
Exp – 03	Conductometric titration.
Exp – 04	Preparation of chrome alum.
Exp – 05	Preparation of borax/ boric acid.
Exp – 06	Estimatio n of Calcium in Chalk by permagnatometry.
Exp – 07	To study the absorption of acid an activated charcoal.
Exp – 08	To determine the pH of given HCl solution by using pH meter.
Exp – 09	Microbiology and Biochemistry:
Exp – 10	Qualitative test of protein & amino acid by any two methods (Millon's test, Biuret test, Ninhydrin test, Xanthoprotein's test, hopkin'scole test). Qualitative test of carbohydrate by any two methods (Molish test, Fehling's test, Benedict's test, Barfoed's test, Phenyl Hydrazine test, iodine test, Seliwanoff's test, Music acid test, Bail's test, Nelson Somogy's method). Methods of sterilisation and preparation of various culture media. Identification of isolated bacteria, Gram staining and gram staining method. Find out the isoelectric point of protein. Protein separation by polyacrylamide gel electrophoresis. Enumeration of microorganism from water/soil sample, colony purification. Purification techniques serial dilution, pour plate and streak plate method

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.	**3**	**1**	**1**		**2**	**1**	**2**
CO2	Able to Evaluate water quality parameters like chloride content and alkalinity.	**3**	**1**	**1**		**1**	**2**	**2**
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.	**3**	**1**	**1**		**1**		**2**
CO4	Know about the principles of qualitative and quantitative analysis of inorganic mixtures.	**3**	**1**	**1**		**1**		**2**
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.	**3**	**1**	**1**		**1**	**2**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf
2. http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf
3. https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf
4. https://www.stem.org.uk/resources/collection/3959/practical-chemistry
5. http://pioneer.netserv.chula.ac.th/~sanongn1/processing.pdf

13. Books recommended:

1. Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, PragatiEdition.
2. Practical Organic Chemistry, A.I.Vogel.
3. Practical Physical Chemistry: B. Viswanathan and P.S.Raghavan.
4. Experimental Inorganic Chemistry –W.G.Palmer.

SEMESTER – IV

1. Name of the Department: CHEMISTRY						
2. Course Name	**POLYMER SCIENCE**			**L**	**T**	**P**
3. Course Code	**CH208**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Students will able to understand the history of macromolecular science, polymer, types and physical state of polymers, polymer processing techniques, mechanism of polymerization, synthesis and applications of polymers.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Remember the history of macromolecular science and basic definition of polymer, polymerization and functionality.
CO2	To know the Classification of polymers, cross-linked copolymers, tacticity, Physical state of polymer; crystallinity, Glass Transition Temperature.
CO3	To create basic Knowledge of the mechanism of addition, condensation, copolymerization, initiators, inhibitors and living polymers.
CO4	Able to evaluate different types of polymer processing techniques as moulding, spinning, calendaring, casting.
CO5	Analyze the importance of synthesis and applications of cross-linked copolymers, addition polymers, copolymers.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: INTRODUCTION**

Brief history of macromlecular science, general characteristics of polymers, some basic definitions (functionality, polymer, polymerization, Homo and hetero chain polymers, copolymer).

Unit-2	**Number of lectures =08**	**Title of the unit: CLASSIFICATION OF POLYMERS**

Natural, synthetic, inorganic, organic, thermoplastics, thermosets, elastomers, fibres, speciality, linear, branched, cross-linked copolymers (random, alternative, block and graft), tacticity (isotactic, and atactic polymers), Physical state of polymer; crystallinity, Glass Transition Temperature

Unit-3	**Number of lectures = 08**	**Title of the unit: TYPES OF POLYMERIZATION**

Addition polymerization (mechanism of free-radical, anionic and cationic polymerization), initiators, inhibitors, living polymers, condensation polymerization, copolymerization, coordination polymerization (bulk, suspension, emulsion, solution).

Unit-4	**Number of lectures = 08**	**Title of the unit: POLYMER PROCESSING**

Compounding, vulcanization reinforcement, calendering, die-casting, filmcasting, compression moulding, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, melt spinning.

Unit-5	**Number of lectures = 08**	**Title of the unit: SYNTHESIS, PROPERTIES AND APPLICATIONS**

Synthesis, properties and applications of polythelene, polypropylene, polytetrafluroethylene pyolystyrene, polyvinyl chloride, polyisoprene, polybutadiene, neoprene, buna-N, buna-s, phenolformal dehyde ureaformaldehyde, polyurethanes.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Remember the history of macromolecular science and basic definition of polymer, polymerization and functionality.	**3**	**1**	**1**	**1**	**2**	**1**	**2**
CO2	To know the Classification of polymers, cross-linked copolymers, tacticity, Physical state of polymer; crystallinity, Glass Transition Temperature.	**3**	**1**	**1**	**1**	**2**	**1**	**2**
CO3	To create basic Knowledge of the mechanism of addition, condensation, copolymerization, initiators, inhibitors and living polymers.	**3**	**1**	**1**	**1**	**2**	**1**	**2**
CO4	Able to evaluate different types of polymer processing techniques as moulding, spinning, calendaring, casting.	**3**	**1**	**1**	**1**	**2**	**1**	**2**
CO5	Analyze the importance of synthesis and applications of cross-linked copolymers, addition polymers, copolymers.	**3**	**1**	**1**	**1**	**2**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. http://chemistry-chemists.com/chemister/Polimers/polymer-science-and-technology.pdf
2. https://byjus.com/jee/polymers/
3. http://chemed.chem.purdue.edu/genchem/topicreview/bp/1polymer/types.html
4. https://www.britannica.com/science/polymer
5. https://www.toppr.com/guides/chemistry/polymers/classification-of-polymers/

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – IV

1. Name of the Department: CHEMISTRY						
2. Course Name	**MEDICINAL DRUGS CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH209**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** To study the basic fundamentals of available drugs in various fields such as antibiotics, antipyretics, analgesics, antimalarial, cardiovascular and newer drugs for the newer disease.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Evaluation and study of introduction, examples and uses of various antibiotics such as β-Lactam, Aminoglycosides and Chloramphenicol provided a better understanding of the antibiotics.
CO2	Study of introduction, classification, synthesis and uses of antipyretics and analgesics like Paracetamol, Aspirin, Phenazone, Phenylbutazone along with Morphine and Codeine create more knowledge about their chemistry.
CO3	Overview, structure and uses of antimalarial drugs like Chloroquine phosphate, Primaquine phosphate, Isopentaquine, Proguanil HCl, Trimethoprim as well as some new antimalarial drugs like Artemisinin and Mefloquine HCl helpful to understand about the chemistry of these drugs.
CO4	Introduction, classification, structure and uses of cardiovascular drugs such as Cardiac glycosides and Digitoxin; Antihypertensive drugs: Losartan and Methyldopa; Antiarrhythmic Agents: Lorcainide HCl and Verapamil HCl gives a better understanding and analyzing ability.
CO5	Knowledge regarding newer available drugs such as Misoprostol, probucol, Tamoxifen Citrate, Flutamide, Methimazole, Ethambutol Hydrochloride, Isoniazid, Rifampicin and Linezolid for the newer disease create more understanding and become essentials of modern life.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: ANTIBIOTICS

Introduction, examples and uses of β-Lactam Antibiotics; Introduction, examples and uses of first, second, third and fourth generation Cephalosporins, Aminoglycosides and Chloramphenicol.

Unit-2	Number of lectures =08	Title of the unit: ANTIPYRETICS AND ANALGESICS

Introduction, examples and uses of β-Lactam Antibiotics; Introduction, examples and uses of first, second, third and fourth generation Cephalosporins, Aminoglycosides and Chloramphenicol.

Unit-3	Number of lectures = 08	Title of the unit: ANTIMALERIALS

Introduction, structure and uses of antimalarial drugs; Chloroquine phosphate, Primaquine phosphate, Isopentaquine, Proguanil Hydrochloride, Trimethoprim. New Antimalarial Drugs; Artemisinin and mefloquine Hydrochloride.

Unit-4	Number of lectures = 08	Title of the unit: CARDIOVASCULAR DRUGS

Introduction and Classification of Cardiovascular Drugs. Structure and uses: Cardiac glycosides; digoxin and digitoxin. Antihypertensive drugs; Losartan, Clonidine Hydrochloride, Methyldopa. Antiarrhythmic Agents; Lorcainide Hydrochloride, Propranolol Hydrochloride, Bretylium tosylate, Verapamil Hydrochloride.

Unit-5	Number of lectures = 08	Title of the unit: ANTIARRHYTHMIC AGENTS

Lorcainide Hydrochloride, Propranolol Hydrochloride, Bretylium tosylate, Verapamil Hydrochloride. Newer Drugs for Newer Disease: Introduction, Structure and uses: Misoprostol, probucol, Tamoxifen Citrate, Ethambutol Hydrochloride, Isoniazid,

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Evaluation and study of introduction, examples and uses of various antibiotics such as β-Lactam, Aminoglycosides and Chloramphenicol provided a better understanding of the antibiotics.	**2**	**1**	**2**	**2**	**-**	**2**	**3**
CO2	Study of introduction, classification, synthesis and uses of antipyretics and analgesics like Paracetamol, Aspirin, Phenazone, Phenylbutazone along with Morphine and Codeine create more knowledge about their chemistry.	**2**	**1**	**1**	**2**	**-**	**2**	**3**
CO3	Overview, structure and uses of antimalarial drugs like Chloroquine phosphate, Primaquine phosphate, Isopentaquine, Proguanil HCl, Trimethoprim as well as some new antimalarial drugs like Artemisinin and Mefloquine HCl helpful to understand about the chemistry of these drugs.	**2**	**1**	**2**	**1**	**-**	**2**	**3**
CO4	Introduction, classification, structure and uses of cardiovascular drugs such as Cardiac glycosides and Digitoxin; Antihypertensive drugs: Losartan and Methyldopa; Antiarrhythmic Agents: Lorcainide HCl and Verapamil HCl gives a better understanding and analyzing ability.	**2**	**1**	**1**	**2**	**-**	**2**	**3**
CO5	Knowledge regarding newer available drugs such as Misoprostol, probucol, Tamoxifen Citrate, Flutamide, Methimazole, Ethambutol Hydrochloride, Isoniazid, Rifampicin and Linezolid for the newer disease create more understanding and become essentials of modern life.	**2**	**1**	**1**	**2**	**-**	**2**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.ysmubooks.am/uploads/Ph_Ch__textbook.pdf
2. https://www.pharmacologicalsciences.us/medicinal-chemistry/classification-of-drugs.html
3. https://www.toppr.com/guides/chemistry/chemistry-in-everyday-life/drugs-and-their-classification/

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – IV

1. Name of the Department: CHEMISTRY						
2. Course Name	**PETRO – CHEMICALS**			**L**	**T**	**P**
3. Course Code	**CH210**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** To provide the fundamental knowledge of origin, composition, exploration and desalting of crude oil with respect to its essentials, profile and methods of distillation. Also, introduce refining and cracking processes of petroleum. Similarly, study the preparations of different chemicals from petroleum.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Introduction of crude oil, exploratory methods, oil reservoirs, transportation of crude oil, the constitution of crude oil and natural gas create and enhance the understanding of the petrochemicals.
CO2	Study of the distillation of crude oil, separation of natural gas along with the meaning of terms such as-pour point depressants, drag reducers, viscosity reducers, flash point, octane number improve the evaluation and applications of petrochemicals.
CO3	Discussion of the different operations such as catalytic cracking, hydrocracking, isomerization, reforming and alkylation concerning the process, mechanism and catalyst used and their applications helpful to evaluate the quality of crude oil.
CO4	The study of various hydrocarbon fuels and their characteristics concerning the manufacturing of the ethylene, acetylene and propylene with their reactions and process diagrams provide new dimensions to the analysis.
CO5	Preparation of ethylene, ethanol, acetaldehyde, acetic acid, vinyl acetate, ethanolamines, and vinyl chloride enhance the knowledge to analyze these chemicals, its chemistry and applications.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:**
Introduction to crude oil, exploratory methods, oil reservoirs, transportation of crude oil, Constitution of crude oil and Natural gas.		
Unit-2	**Number of lectures =08**	**Title of the unit:**
Distillation of crude oil, Separation of natural gas and different fractions based on relative volatilities, Compositions of different distillates. Meaning of terms such as-Pour point depressants, drag reducers, viscocity reducers, flash point, octane number.		
Unit-3	**Number of lectures = 08**	**Title of the unit:**
Detailed discussion of the following operations with respect to process, mechanism, catalysts used and applications, Cracking: Catalytic cracking, Hydrocracking, Isomerization, Reforming, Alkylation.		
Unit-4	**Number of lectures = 08**	**Title of the unit:**
Types of hydrocarbon fuels and their characteristics. Manufacture of the following compounds: ethylene, acetylene, Propylene with reactions and process diagram.		
Unit-5	**Number of lectures = 08**	**Title of the unit:**
Preparation of the following compounds from ethylene: ethanol, acetaldehyde, acetic acid, vinyl acetate, ethanolamines, and vinyl chloride.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Introduction of crude oil, exploratory methods, oil reservoirs, transportation of crude oil, the constitution of crude oil and natural gas create and enhance the understanding of the petrochemicals.	**2**	**1**	**2**	**1**	**-**	**2**	**3**
CO2	Study of the distillation of crude oil, separation of natural gas along with the meaning of terms such as-pour point depressants, drag reducers, viscosity reducers, flash point, octane number improve the evaluation and applications of petrochemicals.	**2**	**1**	**1**	**1**	**-**	**2**	**3**
CO3	Discussion of the different operations such as catalytic cracking, hydrocracking, isomerization, reforming and alkylation concerning the process, mechanism and catalyst used and their applications helpful to evaluate the quality of crude oil.	**2**	**1**	**2**	**1**	**-**	**2**	**3**
CO4	The study of various hydrocarbon fuels and their characteristics concerning the manufacturing of the ethylene, acetylene and propylene with their reactions and process diagrams provide new dimensions to the analysis.	**2**	**1**	**1**	**1**	**-**	**2**	**3**
CO5	Preparation of ethylene, ethanol, acetaldehyde, acetic acid, vinyl acetate, ethanolamines, and vinyl chloride enhance the knowledge to analyze these chemicals, its chemistry and applications.	**2**	**1**	**2**	**1**	**-**	**2**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.britannica.com/science/petrochemical
2. https://energyeducation.ca/encyclopedia/Petrochemical
3. https://www.youtube.com/watch?v=NJbNg3GIkY4
4. https://ihsmarkit.com/products/petrochemical-industry-chemical-economics-handbook.html

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – IV

1. Name of the Department: CHEMISTRY						
2. Course Name	AGRO – CHEMICALS			L	T	P
3. Course Code	CH211			3	1	0
4. Type of Course (use tick mark)				Core (√)	DE ( )	FC ( )
5. Pre-requisite (if any)	10+2 with Chemistry	6. Frequency (use tick marks)	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		Tutorials = 10		Practical = Nil		

8. **COURSE OBJECTIVES:** To understand about Organochlorines, organophosphate and carbamates Insecticides natural organic insecticidesand their mode of action, classification and chemistry of Fungicides, synthesis, mode of action and their applicationsof aromatic acid derivatives like 2,4-D & 2,4,5-T, concepts of formulations (dry and wet)in pesticide and growth regulating hormones.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Remembergeneral introduction, chemical classification of Insecticides and natural organic insecticides like pyrethroids and pyrethrins.
CO2	Comprehension of concepts of formulations (dry and wet)in pesticide and synthesis, applications of rodenticides
CO3	Understanding of chemistry of fungicides and different classes of fungicides and dithiocarbamates as potent fungicides.
CO4	Able toevaluatedifferent types of commercial synthetic methodologies of 2,4-D & 2,4,5-T and rodenticides likeZinc phosphides, Warfarin, sodium monofluoroacetate.
CO5	Analyze and compare Organophosphate insecticides over Organochlorines Insecticides, Synthesis, mode of action, uses and formulation of Organochlorines, Organophosphates and carbamates insecticides.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit:

General introduction, Types of pesticides: stomach poisons, contact poisons, systemic poisons, fumigants. Chemical classification of pesticides: Insecticides, fungicides, herbicides, rodenticides, moluscicides, acaricides, nematicides. Natural organic insecticidcs: pyrethroids and pyrethrins.

Unit-2	Number of lectures =08	Title of the unit:

General introduction, synthesis, mode of action and applications: (a) Organochlorine Insecticides: DDT, BHC, aldrin, endosulfon. (b) Organophosphorus insecticides: Phosphamidon (Dimecron), Malathion, methyl parathion. (c) Carbamate insecticides: Carbaryl, Carbofuran.

Unit-3	Number of lectures = 08	Title of the unit:

General introduction, synthesis, mode of action and applications: (a) Inorganic fungicides: Sulphur, Lime sulphur, copper sulphate, Burgundy mixture, copper oxychloride, Dithiocarbamates: Ziram, thiram and Zineb.

Unit-4	Number of lectures = 08	Title of the unit:

General introduction, synthesis, structure and applications: Herbicides: 2, 4, dichloro phenoxy acetic acid (2, 4-D), alachlor, sulphonyl urea compounds. Rodenticides- Zinc phosphides, Warfarin, sodium monofluoroacetate.

Unit-5	Number of lectures = 08	Title of the unit:

Plant growth regulators: Gibberelic and indole acetic acids, cytokinins. Formulation of pesticides: Dry formulation: Dusts, granules, wettable powders, seed disinfectants liquid formulation: Emulsions and suspensions.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Remembergeneral introduction, chemical classification of Insecticides and natural organic insecticides like pyrethroids and pyrethrins.	3	1	1		2	2	2
CO2	Comprehension of concepts of formulations (dry and wet)in pesticide and synthesis, applications of rodenticides	3	1	1		2	2	2
CO3	Understanding of chemistry of fungicides and different classes of fungicides and dithiocarbamates as potent fungicides.	3	1	1		2	2	2
CO4	Able toevaluatedifferent types of commercial synthetic methodologies of 2,4-D & 2,4,5-T and rodenticides likeZinc phosphides, Warfarin, sodium monofluoroacetate.	3	1	1		2	2	2
CO5	Analyze and compare Organophosphate insecticides over Organochlorines Insecticides, Synthesis, mode of action, uses and formulation of Organochlorines, Organophosphates and carbamates insecticides.	3	1	1		2	2	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.worldofchemicals.com/629/chemistry-articles/agrochemicals-types-and-their-effects.html
2. https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/agrochemicals
3. https://www.britannica.com/technology/agrochemical
4. https://byjus.com/biology/effects-of-agrochemicals/

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – IV

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL WASTE TREATMENT**			**L**	**T**	**P**
3. Course Code	**CH212**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Basic knowledge of industrial waste management technologies, acquaintance with basic waste treatment technologies and environmental legislations to curb hazardous wastes will be taught to students.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Analysis working methodologies of treatment technologies to tackle waste from household and industries is done
CO2	An evaluation of hazardous impacts of wastes on climate and human health create awareness among students.
CO3	Evaluation of different remedial measures to check waste volume and strength develops a sense of sustainable environmental measures.
CO4	Awareness about waste generation, its impact and mitigation strategies would be created to remove hazardous wastes.
CO5	Remembrance of important aspects of environmental audits would lead to its application in industries.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: INTRODUCTION

Types of industries and industrial pollution; Characteristics of industrial wastes; Population equivalent; Bioassay studies; effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health; Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.

Unit-2	Number of lectures =08	Title of the unit: CLEANER PRODUCTION

Waste management Approach; Waste Audit; Volume and strength reduction; Material and process modifications Recycle, reuse and byproduct recovery; Applications.

Unit-3	Number of lectures = 08	Title of the unit: POLLUTION FROM MAJOR INDUSTRIES

Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Dairy, Sugar, Paper, distilleries, Steel plants, thermal power plants; Wastewater reclamation concepts.

Unit-4	Number of lectures = 08	Title of the unit: TREATMENT TECHNOLOGIES

Equalisation; Neutralisation; Removal of suspended and dissolved organic solids; Chemical oxidation, Adsorption Removal of dissolved inorganics; Combined treatment of industrial and municipal wastes; Residue management; Dewatering; Disposal.

Unit-5	Number of lectures = 08	Title of the unit: HAZARDOUS WASTE MANAGEMENT

Hazardous wastes - Physico chemical treatment, solidification, incineration, Secure land fills.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Analysis working methodologies of treatment technologies to tackle waste from household and industries is done	**2**		**2**	**2**	**2**	**3**	**1**
CO2	An evaluation of hazardous impacts of wastes on climate and human health create awareness among students.	**2**		**2**			**3**	**2**
CO3	Evaluation of different remedial measures to check waste volume and strength develops a sense of sustainable environmental measures.	**3**	**1**	**2**	**2**	**2**	**3**	**1**
CO4	Awareness about waste generation, its impact and mitigation strategies would be created to remove hazardous wastes.	**2**		**1**	**2**		**3**	**2**
CO5	Remembrance of important aspects of environmental audits would lead to its application in industries.		**3**	**2**				**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://condorchem.com/en/industrial-wastewater-treatment/
2. https://www.chemicalprocessing.com/articles/2018/understand-industrial-wastewater-treatment/
3. https://www.encyclopedia.com/environment/encyclopedias-almanacs-transcripts-and-maps/industrial-waste-treatment
4. https://www.water.wa.gov.au/__data/assets/pdf_file/0008/4040/89343.pdf

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – IV

1. Name of the Department: CHEMISTRY						
2. Course Name	**WATER TREATMENT AND ANALYSIS**			**L**	**T**	**P**
3. Course Code	**CH213**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** The aim of this course is to introduce the students to the area of water and wastewater treatment. The course will cover water chemistry; characteristics of water & wastewater; primary, secondary & tertiary treatment processes; sludge disposal; and design of water and wastewater treatment plants.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Ability to describe the purpose and operational steps of key water treatment processes used to improve water quality including: Coagulation, precipitation, chlorination etc.
CO2	Identify the parameters that characterize the constituents found in potable water and wastewater;
CO3	Illustrate the fundamentals of water and wastewater treatment
CO4	Recognise the common physical, chemical and biological unit operations encountered in treatment processes
CO5	Examine biological parameters of water.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: PURIFICATION OF WATER FOR DRINKING PURPOSE

Clarification, coagulation, contact & electro chemical coagulation, sterilization & disinfections of water, precipitation, aeration, ozonisation and Chlorination.

Unit-2	Number of lectures =08	Title of the unit: DETERMINATION OF HARDNESS AND SOFTENING METHODS FOR WATER

Determination of hardness of water: Titration methods - complexometric method using EDTA.
Water softening methods: lime soda process, permutit or zeolite process, Ion exchange process or demineralization of water, Desalination of water: elecrodiaysis and Reverse osmosis.

Unit-3	Number of lectures = 08	Title of the unit: WATER ANALYSIS

Water analysis: sampling of water for analysis - chemical substances affecting potability - colour, turbidity odour, taste, temperature, pH and electrical conductivity.
Analysis of solids present in water: suspended solids, dissolved solids, total acidity, alkalinity, free CO2, and free chlorine.

Unit-4	Number of lectures = 08	Title of the unit: ANALYSIS OF CHEMICAL SUBTANCES AFFECTING HEALTH

Analysis of chemical substances affecting health: Ammonia, Nitrate, Nitrite, cyanide, sulphate, sulphide, chloride, fluoride.
Analysis of chemical substances indicative of pollution: Dissolved oxygen, Bio Chemical oxygen demand (BOD), Chemical oxygen demand (COD).

Unit-5	Number of lectures = 08	Title of the unit: BACTERIOLOGICAL EXAMINATION OF WATER

Bacteriological examination of water: total count test; E.coli test, E.coli index, most probable number method, Biological examination of water.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Ability to describe the purpose and operational steps of key water treatment processes used to improve water quality including: Coagulation, precipitation, chlorination etc.	**3**	**3**	**3**	**1**	**1**	**2**	**3**
CO2	Identify the parameters that characterize the constituents found in potable water and wastewater;	**3**	**3**	**3**	**1**	**1**	**2**	**3**
CO3	Illustrate the fundamentals of water and wastewater treatment	**3**	**3**	**3**	**2**	**1**	**2**	**3**
CO4	Recognise the common physical, chemical and biological unit operations encountered in treatment processes	**3**	**3**	**3**	**2**	**1**	**2**	**3**
CO5	Examine biological parameters of water.	**3**	**3**	**3**	**2**	**1**	**2**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://sswm.info/sites/default/files/reference_attachments/MCCAFFREY%20ny%20Water%20Quality%20Parameters%20&%20Indicators.pdf
2. https://www.youtube.com/watch?v=6Ot2t9YyzKU&list=RDCMUCYa1WtI-vb_bx-anHdmpNfA&start_radio=1&rv=6Ot2t9YyzKU&t=11
3. https://wedc-knowledge.lboro.ac.uk/resources/e/mn/006-Bacteriological-testing-of-water.pdf
4. https://www.slideshare.net/doctortvrao/bacteriology-of-water-and-analysis-basics

13. Books recommended:

1. Industrial chemistry (including chemical - engineering) - B.K. Sharma - Goel publishing house, Meerut.
2. Pollution control in process industries - S.P. Mahajan - Tata Megraw - hill Publishing company Ltd., New Delhi.
3. Water pollution and management - C.K. Varashney - wiley Eastern Ltd., Chennai - 20.

SEMESTER – IV

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL CHEMISTRY LAB – IV**			**L**	**T**	**P**
3. Course Code	**CH214**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. **COURSE OBJECTIVES:** Student will be able to work effectively and safely in a laboratory environment, practical/technical/ communication skills, concepts to solve qualitative and quantitative problems,transferable skills like ability to work in teams as well as independently.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.
CO2	Able to Evaluate water quality parameters like DO,BOD,COD,TDS and alkalinity.
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.
CO4	Know the preparation of resins and acetanilide.
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.

10. Syllabus

Exp – 01	Preparation of urea formaldehyde resin.
Exp – 02	Preparation of Phenol formaldehyde (Bakelite) resin.
Exp – 03	Preparation of Nylon 6, 6.
Exp – 04	Preparation of Acetyl Salicylic acid (Aspirin).
Exp – 05	Preparation of acetanilide.
Exp – 06	Preparation of Methyl salicylate (oil of winter).
Exp – 07	Determination of total hardness in the given water sample.
Exp – 08	Determination of Dissolved oxygen (DO) in the given water sample.
Exp – 09	Determination of Biological oxygen demand (BOD) in the given water sample.
Exp – 10	Determination of Chemical oxygen demand (COD) in the given water sample.
Exp – 11	Determination of Total dissolved solid (TDS) in the given water sample.
Exp – 12	Determination of alkali content in antacid tablet using HCl.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.	**3**	**1**	**1**		**2**	**1**	**2**
CO2	Able to Evaluate water quality parameters like DO,BOD,COD,TDS and alkalinity.	**3**	**1**	**1**		**1**	**2**	**2**
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.	**3**	**1**	**1**		**1**		**2**
CO4	Know the preparation of resins and acetanilide.	**3**	**1**	**1**		**1**		**2**
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.	**3**	**1**	**1**		**1**	**2**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf
2. http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf
3. https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf
4. https://www.stem.org.uk/resources/collection/3959/practical-chemistry
5. http://pioneer.netserv.chula.ac.th/~sanongn1/processing.pdf

13. Books recommended:

1. Advanced Organic Chemistry, Bahl & Bahl, S. Chand & Co. Ltd.
2. Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, Pragati Edition.
3. Practical Organic Chemistry A.I. Vogel.
4. Practical Physical Chemistry: B. Viswanathan and P.S. Raghavan.
5. Experimental Inorganic Chemistry –W.G.Palmer.

SEMESTER – V

1. Name of the Department: CHEMISTRY						
2. Course Name	CHROMATOGRAPHY TECHNIQUES			L	T	P
3. Course Code	CH301			3	1	0
4. Type of Course (use tick mark)				Core (√)	DE ( )	FC ( )
5. Pre-requisite (if any)	10+2 with Chemistry	6. Frequency (use tick marks)	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. **COURSE OBJECTIVES:** Students able to understand Separation techniques such as Thin layer chromatography, Paper chromatography, Gas chromatography, High performance Liquid Chromatography and Ion exchange chromatography

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the chromatographic techniques and its classification.
CO2	Evaluate Thin layer chromatography; principle and its applications. Paper chromatography and its applications. Separation of amino acid mixture.
CO3	Comprehension of Principles of gas-liquid chromatography, Instrumentation and its Industrial applications.
CO4	Able to discuss Normal and reverse phase HPLC, Isocratic and gradient elution, Instrumentation; mobile phase reservoir, column and detector and Industrial applications of HPLC.
CO5	Analyze the action of resins, experimental techniques, applications, separation of metal ions, separation of chloride and Bromide ions - removal of interfering radicals.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: SEPARATION TECHNIQUES

Chromatography, Classification of Chromatographic methods, Elution in column chromatography, chromatograms, distribution constant, retention time, stationary phase, mobile phase, principle of adsorption and partition chromatography, column chromatography; principle, adsorbents used, preparation of column, adsorption, elution.

Unit-2	Number of lectures =08	Title of the unit: THIN LAYER CHROMATOGRAPHY

principle, choice of adsorbent and solvent, Rf value, applications. Paper chromatography; solvents used, principle, Rf value, factors influencing Rf value, applications. Separation of amino acid mixture.

Unit-3	Number of lectures = 08	Title of the unit: GAS CHROMATOGRAPHY

Introduction, Principles of gas-liquid chromatography, Instrumentation; Carrier gas system, Sample injection, Columns, Stationary phase, Detectors (Flame Ionization, Electron capture and Thermal conductivity) and Industrial applications.

Unit-4	Number of lectures = 08	Title of the unit: HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

Introduction of HPLC, Normal and reverse phase HPLC, Isocratic and gradient elution, Instrumentation; mobile phase reservoir, column and detector (UV-visible absorption, Electrochemical) and Industrial applications of HPLC.

Unit-5	Number of lectures = 08	Title of the unit: ION EXCHANGE CHROMATOGRAPHY

principle, resins, action of resins, experimental techniques, applications, separation of metal ions, separation of chloride and Bromide ions - removal of interfering radicals.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Understand the chromatographic techniques and its classification.	3	1	1	2	2	1	2
CO2	Evaluate Thin layer chromatography; principle and its applications. Paper chromatography and its applications. Separation of amino acid mixture.	3	1	1	2	2	1	2
CO3	Comprehension of Principles of gas-liquid chromatography, Instrumentation and its Industrial applications.	3	1	1	2	2	1	2
CO4	Able to discuss Normal and reverse phase HPLC, Isocratic and gradient elution, Instrumentation; mobile phase reservoir, column and detector and Industrial applications of HPLC.	3	1	1	2	2	1	2
CO5	Analyze the action of resins, experimental techniques, applications, separation of metal ions, separation of chloride and Bromide ions - removal of interfering radicals.	3	1	1	2	2	1	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://microbenotes.com/chromatography-principle-types-and-applications/
2. https://www.khanacademy.org/science/class-11-chemistry-india/xfbb6cb8fc2bd00c8:in-in-organic-chemistry-some-basic-principles-and-techniques/xfbb6cb8fc2bd00c8:in-in-methods-of-purification-of-organic-compounds/v/basics-of-chromatography
3. https://www.slideshare.net/nadeemakhter7374/chromatography-34247423
4. http://www.biologydiscussion.com/biochemistry/chromatography-techniques/top-12-types-of-chromatographic-techniques-biochemistry/12730

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – V

1. Name of the Department: CHEMISTRY						
2. Course Name	**PROCESS IN ORGANIC CHEMICALS MANUFACTURING**			**L**	**T**	**P**
3. Course Code	**CH302**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Interest will be developed among students for industrial organic chemistry and introduction of basic organic chemicals' manufacturing techniques, organic reaction mechanisms and their applications in industrial chemistry will be taught.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	An understanding of the hazardous outcomes of certain commercial procedures is and the alternatives are suggested.
CO2	Commercial preparations of important organic substances of industrial use are analyzed for their procedural feasibility.
CO3	Merits and demerits of various organic procedures like batch and continuous preparations are analysed in context with organic chemicals' manufacture.
CO4	How common organic reactions are applied in commercial chemicals' manufacture is done along with their mechanistic action.
CO5	Interest for organic synthesis in context with industrial chemistry is created among students.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: NITRATION**

Introduction - Nitrating agents and mechanism of nitration process such as nitration: i) Benzene to nitrobenzene and m-dinitrobenzene ii) Chlorobenzene to o- and pnitrochlorobenzenes iii) Toluene. Continuous vs batch nitration.

Unit-2	**Number of lectures =08**	**Title of the unit: SULPHONATION**

Introduction, sulphonating agents, Chemical and physical factors affect sulphonation, mechanism of sulphonation reactions, Commercial sulphonation of benzene, naphthalene, Toluene, batch vs continuous sulphonation.

Unit-3	**Number of lectures = 08**	**Title of the unit: ALKYLATION**

Introduction, Types of alkylation, Alkylating agents, mechanism of alkylation reactions, manufacture of alcohol, N-alkyl anilines (mono dimethyl and ethyl anilines.).

Unit-4	**Number of lectures = 08**	**Title of the unit: ESTERIFICATION**

Introduction, Esterfication by organic acids, by addition of unsaturated compounds, esterification of carboxyl acid derivatives, commercial manufacture of ethyl acetate, vinyl acetate, cellulose acetate.

Unit-5	**Number of lectures = 08**	**Title of the unit: HALOGENATION**

Introduction - Reagents for halogenations, mechanism of halogenation, , halogenation of aromatics. Commercial manufactures - chlorobenzenes, chloral, monochloracetic and chloromethanes, dichlorofluoromethane.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	An understanding of the hazardous outcomes of certain commercial procedures is and the alternatives are suggested.	**2**	**1**	**1**	**1**	**2**	**3**	**2**
CO2	Commercial preparations of important organic substances of industrial use are analyzed for their procedural feasibility.	**1**				**1**	**2**	**1**
CO3	Merits and demerits of various organic procedures like batch and continuous preparations are analysed in context with organic chemicals' manufacture.	**2**	**1**			**2**	**2**	**1**
CO4	How common organic reactions are applied in commercial chemicals' manufacture is done along with their mechanistic action.	**2**						**1**
CO5	Interest for organic synthesis in context with industrial chemistry is created among students.	**2**	**1**	**1**		**1**	**2**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.britannica.com/technology/chemical-industry/Organic-chemicals
2. http://www.ilocis.org/documents/chpt77e.htm
3. https://www.accessengineeringlibrary.com/browse/handbook-of-industrial-chemistry-organic-chemicals/c9780071410373ch01
4. http://www.chemistryexplained.com/Hy-Kr/Industrial-Chemistry-Organic.html

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – V

1. Name of the Department: CHEMISTRY						
2. Course Name	**PHYTOCHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH303**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. **COURSE OBJECTIVES:** Students will be acquainted with important terpenoids, alkaloids and hormones their synthesis and structure elucidation is done in context with industrial chemistry. A special emphasis will be laid on plant based phytochemicals and their medicinal utility.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Isolation and separation procedures are understood to separate individual components in natural products chemistry.
CO2	Structure elucidation of various alkaloids, terpenoids is done to better understand the fundamentals of phytochemistry.
CO3	Classification and structure of vitamins is understood and utility of vitamins is applied in biological structures.
CO4	Phytopharmaceuticals and their utility is analysed in context with industrial chemistry
CO5	Physiological action of important steroids and hormones is evaluated.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: TERPENOIDS

Introduction, nomenclature, occurrence, general properties, classification, and isolation of terpenoids, isoprene rule; synthesis of Citral and Menthol. Carotenoids: Introduction, classification, and isolation of carotenoids.

Unit-2	Number of lectures =08	Title of the unit: ALKALOIDS

Introduction occurrence, functions, nomenclature, chemical classification, isolation, and general properties of alkaloid. Introduction and physiological action; Ephedrine, Adreneline or Epinephrine, Nor adreneline or Nor epinephrine, Nicotine, atropine.

Unit-3	Number of lectures = 08	Title of the unit: STEROIDS AND HORMONES

Introduction, occurrence, structure and physiological action; cholesterol, Ergosterol. Steroidal hormones; Progesterone, Testosterone, Androgen, Oestrogens.

Unit-4	Number of lectures = 08	Title of the unit: VITAMINS

Introduction, Classification, Sources of vitamins and their deficiency diseases. Physiological function of water and fat soluble vitamins. Structure and uses; Vit. A, Vit. B1, B2 B6, and Vit. C.

Unit-5	Number of lectures = 08	Title of the unit: PHYTOPHARMACEUTICALS

Recent development and commercialization of plant derived natural products. Structure and medicinal uses of caffeine, theophylline and theobromine.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Isolation and separation procedures are understood to separate individual components in natural products chemistry.	**2**				**2**	**2**	**2**
CO2	Structure elucidation of various alkaloids, terpenoids is done to better understand the fundamentals of phytochemistry.	**2**				**2**	**1**	**1**
CO3	Classification and structure of vitamins is understood and utility of vitamins is applied in biological structures.	**2**						**2**
CO4	Phytopharmaceuticals and their utility is analysed in context with industrial chemistry	**2**	**1**	**1**		**2**	**1**	**2**
CO5	Physiological action of important steroids and hormones is evaluated.	**2**				**1**		**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://medlineplus.gov/vitamins.html
2. https://www.health.harvard.edu/staying-healthy/listing_of_vitamins
3. https://medlineplus.gov/steroids.html
4. https://www.versusarthritis.org/about-arthritis/treatments/drugs/steroids/

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Princ--iples of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – V

1. Name of the Department: CHEMISTRY						
2. Course Name	**UNIT OPERATION IN CHEMICAL INDUSTRY**			**L**	**T**	**P**
3. Course Code	**CH304**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** The purpose of this course is to develop the deep understanding of theory distillation and several column separations techniques and to comprehend the filtration and drying of mixed component in a binary/ ternary component with the context of industrial separation techniques including solid state chemistry with nucleation, growth and crystallization mechanism of solid crystal for industrial perspective.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will create an understanding of the design and application of an analysis related to a question of relevance based on experience in separations techniques.
CO2	Students will create an understanding of the connection between common approximation methods and standard chemical adsorption /absorption.
CO3	Students will be able to understand about the ingredients of filtering and drying of the commercial products.
CO4	Students will have a firm foundation in the fundamentals and applications of crystallization process.
CO5	Students will gain an understanding of extraction of the compounds in mixtures.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: DISTILLATION

Introduction, Bath and continuous distillation, Separation of azeotropes, Plates columns and packed columns Absorption: Introduction: Equipments- packed columns spray Columns, bubble columns, packed bubble columns, mechanically agitated contractors.

Unit-2	Number of lectures =08	Title of the unit: EVAPORATION

Introduction, Equipments- short tube (standard) Evaporator forced circulation evaporators, falling film evaporators, climbing film (upward flow) evaporators, wiped (agitated) film evaporator.

Unit-3	Number of lectures = 08	Title of the unit: FILTRATION

Filtration: Introduction, filter media and filter aids, equipments- plate and frame filter press, nutch filter, rotary drum filter, sparkler filter, candle filter, bag filter, centrifuge Drying: Introduction, free moisture, bound moisture drying curve; equipments- tray dryer, rotary dryer, flash dryer, fluid bed dryer, drum dryer, spray dryer.

Unit-4	Number of lectures = 08	Title of the unit: CRYSTALLIZATION

Introduction: solubility, super-saturation nucleation, crystal growth; Equipment- tank crystallizer, agitated crystallizer, evaporator, crystallizer, draft tube crystallizer.

Unit-5	Number of lectures = 08	Title of the unit: EXTRACTION

Introduction: selection of solvent; Equipments- Spray column, packed column rotating disc column, mixer-settler. Mixing- Introduction; mixing of liquid-liquid solid- Solid, liquid-solid systems..

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will create an understanding of the design and application of an analysis related to a question of relevance based on experience in separations techniques.	**3**	**1**	**1**		**1**	**3**	
CO2	Students will create an understanding of the connection between common approximation methods and standard chemical adsorption /absorption.	**3**	**1**	**1**		**1**	**3**	
CO3	Students will be able to understand about the ingredients of filtering and drying of the commercial products.	**3**	**1**	**3**		**2**	**1**	
CO4	Students will have a firm foundation in the fundamentals and applications of crystallization process.	**3**	**1**	**3**		**2**	**1**	
CO5	Students will gain an understanding of extraction of the compounds in mixtures.	**3**	**1**	**1**		**2**	**1**	

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://sites.google.com/a/sdsenthil.com/chemical-technology/chemical-processing-unit-operation
2. https://ceng.tu.edu.iq/ched/images/lectures/chem-lec/st4/c5/lec%201.pdf
3. https://www.unibo.it/en/teaching/course-unit-catalogue/course-unit/2016/367440
4. https://www.youtube.com/watch?v=H_Nc7SJwDco

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – V

1. Name of the Department: CHEMISTRY						
2. Course Name	**PULP, PAPER, LEATHER AND TEXTILE INDUSTRY**			**L**	**T**	**P**
3. Course Code	**CH305**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** To provide a basic understanding of the nature of chemical materials and the emerging trend. In addition, it seeks to address the massive drive to understand these materials and improve their properties in order to meet material requirements

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Student will be able to apply the knowledge to produce various types of pulp and papers.
CO2	Student will be able know the processing techniques to produce special types of papers.
CO3	Student will be able to demonstrate the basic mechanism and processes involved in leather industry.
CO4	Student will be able to know about a challenge which arises from leather industries and their handling**.**
CO5	Student will able to know about Indian industries and products.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: PULP AND PAPER

Introduction - Manufacture of pulp, Sulphate or Kraft pulp, Soda pulp, Sulphite pulp Rag pulp, Beating, refining, filling, sizing and coloring , manufacture of paper and paper making additives; processing aids, functional additives, strength additives and binders.

Unit-2	Number of lectures =08	Title of the unit: SPECIAL TYPES OF PAPERS AND THEIR MANUFACTURING PROCESS

Ammonia paper, Art paper, Bituminized water proof paper, Emery Paper, Toilet paper, Wall paper , Wax coated paper and polymeric modified papers.

Unit-3	Number of lectures = 08	Title of the unit: LEATHER INDUSTRY-I

Introduction - Constituents of Animal Skin - Preparing skins and hides - Cleaning and soaking - Liming and degreasing.

Unit-4	Number of lectures = 08	Title of the unit: LEATHER INDUSTRY-II

Introduction, Manufacture of leather, Preparation of hides for tanning, Vegetable, chrome and oil tanning - Byproduct.

Unit-5	Number of lectures = 08	Title of the unit: TEXTILES CHEMISTRY

Indian textile industries, general consideration of textile fibres: cotton, wool, silk, and rayon fibres; General considerations of synthetic fibres; Indetification of textile fibres; Water soluble resins, and epoxy resins.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Student will be able to apply the knowledge to produce various types of pulp and papers.	**1**	**1**	**1**	**2**	**3**	**3**	**1**
CO2	Student will be able know the processing techniques to produce special types of papers.	**1**	**1**	**1**	**2**	**3**	**3**	**1**
CO3	Student will be able to demonstrate the basic mechanism and processes involved in leather industry.	**1**	**1**	**1**	**2**	**3**	**3**	**1**
CO4	Student will be able to know about a challenge which arises from leather industries and their handling**.**	**1**	**1**	**1**	**3**	**3**	**3**	**1**
CO5	Student will able to know about Indian industries and products.	**1**	**1**	**2**	**3**	**3**	**3**	**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=4pWBknxLTYw
2. https://www.youtube.com/watch?v=z6QnUCc7ZCg
3. https://www.youtube.com/watch?v=5Lusmpg_TdA
4. https://www.youtube.com/watch?v=Lu31Zt8f3xo

13. Books recommended:

1. Chemical process industries N.R Nerris shreve
2. Chemical process principales: part 1 & II – O.A / Hougen, K.M Watson RA Ragatz (CBS)
3. Shrev's Chemical process Industries: 5th edition – George T. Austin, Mc Graw Hill Book Co.
4. Handbook of industrial chemistry: Volume I & II , KH Davis , FS Berner, CBS Publication.
5. Plastic Additives Technology Hand Book: Himadri Panda, Engineers India Research Institute.
6. Industrial Chemistry B.K.Sharma, goel publishing house

SEMESTER – V

1. Name of the Department: CHEMISTRY						
2. Course Name	**DYES**			**L**	**T**	**P**
3. Course Code	**CH306**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Students will be able to understand era and history, color and chemical constitution Develop basic chemical reaction and synthesis of azodyes and applications of some typically used dye.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Remember the era of dyes and synthesis of benzene intermediates.
CO2	Understand the chemistry of the dyes with respect to general structural features, mode of application to fiber, color shades, classification, mode of application, Color and chemical constitution
CO3	Able to evaluate different types of Anthraquinone Dyes like Anthraquinone mordant dyes, Anthraquinone vat dyes, Anthraquinone acid dyes, Anthraquinone Disperse dye.
CO4	Able to create basic Knowledge of azodyes, Diazotization, Diazo Coupling, Acidic azo dyes, Basic azo dyes, Direct or substantive azodyes, Mordant azodyes
CO5	Analyze the important applications of Phenolphthalein, fluorescein, Eosin, Malachite green, Methylene blue, Indigo. Naphthol yellow-S, Crystal violet.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: CHEMISTRY OF INTERMEDIATES

Introduction of the History of Dyes. Landmarks in the historical development from Natural to synthetic dyes. Benzene intermediates-Chloronitrobenzenes, Nitroanilines, Bromonitroanilines, Nitroanisole.

Unit-2	Number of lectures =08	Title of the unit: CLASSIFICATION

Introduction and classification of dyes on the basis of structure and the mode of application to the fibre. Colour and chemical constitution of dyes; Chemistry of the dyes with respect to general structural features, mode of application to fibre, colour shades, synthesis of typical 4-5 dyes., uses.

Unit-3	Number of lectures = 08	Title of the unit: ANTHRAQUINONE DYES

Anthraquinone mordant dyes; Alizarin, Alizarin Orange, Alizarin Red S. Anthraquinone vat dyes; Indanthrone blue, Pyranthrone. Anthraquinone acid dyes, Anthraquinone Disperse dye.

Unit-4	Number of lectures = 08	Title of the unit: AZO DYES

Diazotization, Diazo Coupling, Types of Azo dyes; Acidic azo dyes (Methyl Orange, Tartrazine). Basic azo dyes; aniline, butter yellow. Direct or substantive azodyes; Congored. Ingrain azodyes; para red.Mordant azodyes; Eriochrome Black-T. synthetic fibre dyes; red disperse dye.

Unit-5	Number of lectures = 08	Title of the unit: MISCELLANEOUS DYES

Structure and uses; Phenolphthalein, fluorescein, Eosin, Malachite green, Methylene blue, Indigo. Naphthol yellow-S, Crystal violet.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Remember the era of dyes and synthesis of benzene intermediates.	**3**	**1**	**1**	**2**	**2**	**1**	**2**
CO2	Understand the chemistry of the dyes with respect to general structural features, mode of application to fiber, color shades, classification, mode of application, Color and chemical constitution	**3**	**1**	**1**	**2**	**2**	**1**	**2**
CO3	Able to evaluate different types of Anthraquinone Dyes like Anthraquinone mordant dyes, Anthraquinone vat dyes, Anthraquinone acid dyes, Anthraquinone Disperse dye.	**3**	**1**	**1**	**2**	**2**	**1**	**2**
CO4	Able to create basic Knowledge of azodyes, Diazotization, Diazo Coupling, Acidic azo dyes, Basic azo dyes, Direct or substantive azodyes, Mordant azodyes	**3**	**1**	**1**	**2**	**2**	**1**	**2**
CO5	Analyze the important applications of Phenolphthalein, fluorescein, Eosin, Malachite green, Methylene blue, Indigo. Naphthol yellow-S, Crystal violet.	**3**	**1**	**1**	**2**	**2**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.britannica.com/technology/dye
2. https://www.ncbi.nlm.nih.gov/books/NBK385442/
3. https://www.worldofchemicals.com/407/chemistry-articles/colors-family-inks-dyes-and-pigments.html
4. https://textilelearner.blogspot.com/2015/01/different-types-of-dyes-with-chemical.html

13. Books recommended:

1. Chemical Thermodynamics by R.P.Rastogi et al
2. Principles of physical chemistry by Puri Sharma and Pathan
3. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
5. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
6. Atkin's Physical Chemistry, Atkin, Oxford Press.

SEMESTER – V

1. Name of the Department: CHEMISTRY						
2. Course Name	**INDUSTRIAL CHEMISTRY LAB – V**			**L**	**T**	**P**
3. Course Code	**CH307**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. **COURSE OBJECTIVES:** Student will be able to work effectively and safely in a laboratory environment, practical/technical/ communication skills, concepts to solve qualitative and quantitative problems,transferable skills like ability to work in teams as well as independently.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.
CO2	Able to detect adulterants in the given food sample.
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.
CO4	Explain the principles of chromatographic techniques.
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.

10. Syllabus

Exp – 01	Separation of amino acid by Thin layer chromatography.
Exp – 02	Separation of amino acid by paper chromatography.
Exp – 03	Separation of sugar by Thin layer chromatography.
Exp – 04	Isolation of lactose & casein.
Exp – 05	Isolation of lycopene from tomato.
Exp – 06	Isolation of caffeine from tea.
Exp – 07	Isolation of piperine from black pepper.
Exp – 08	Isolation of eugenol from cloves.
Exp – 09	Isolation of nicotine from tobacco.
Exp – 10	Determination of protein content of food.
Exp – 11	Determination of fat content of food.
Exp – 12	Determination of acetic acid content of vinegar.
Exp – 13	Determination of acid value of oil.
Exp – 14	Preparation of methyl orange.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Remember to keep records of all performed experiments in themanner which is required in laboratory.	**3**	**1**	**1**		**2**	**1**	**2**
CO2	Able to detect adulterants in the given food sample.	**3**	**1**	**1**		**1**	**2**	**2**
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.	**3**	**1**	**1**		**1**		**2**
CO4	Explain the principles of chromatographic techniques.	**3**	**1**	**1**		**1**		**2**
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.	**3**	**1**	**1**		**1**	**2**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=MTsn1-ToKqQ 2.
2. http://www.bellevuecollege.edu/wp-content/uploads/sites/140/2014/06/aspirin_tablets_titration.pdf
3. https://www.frontiersin.org/articles/10.3389/fonc.2015.00196/full
4. https://www.youtube.com/watch?v=1tmqUVSVPo4
5. https://www.youtube.com/watch?v=KZ35K05SA7g

13. Books recommended:

1. Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, PragatiEdition.
2. Practical Organic Chemistry A.I.Vogel.
3. Practical Physical Chemistry : B. Viswanathan and P.S.Raghavan.
4. Experimental Inorganic Chemistry –W.G.Palmer.

SEMESTER – VI

1. Name of the Department: CHEMISTRY						
2. Course Name	**SPECTROSCOPIC TECHNIQUES**			**L**	**T**	**P**
3. Course Code	**CH308**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** Students able to understand the interaction of electromagnetic radiation with the materials, spectroscopic techniques like Ultraviolet, FT-IR, Nuclear Magnetic Resonance spectroscopy and mass spectrometry.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understanding Wave-like propagation of light, electronic transitions, instrumentation, conjugated systems and transition energies, Woodward – Fieser rules for calculation of wave length.
CO2	Comprehension of absorption in the infrared region, theory of infrared spectroscopy, instrumentation, molecular vibrations, factors affecting vibrational frequencies, characteristic absorptions in common classes of compounds.
CO3	To create basics of NMR spectroscopy, instrumentation, chemical shift, equivalent and nonequivalent protons, spin-spin splitting and vicinal coupling.
CO4	Able to evaluate the NMR spectra of some representative compounds: Hydrocarbons, Aldehydes, Ketones, Acids and Alcohols, Applications of NMR spectroscopy.
CO5	Analyze the theory, instrumentation, important useful terms in mass spectrometry; molecular ion peak, metastable peak, fragmentation patterns of various functional groups (alkanes, alkenes, alkynes, alcohols, ketones, aldehydes), Mclafferty rearrangements.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: UV SPECTROSCOPY

Wave-like propagation of light, absorption of electromagnetic radiation by organic molecules allowed and forbidden transitions, instrumentation, conjugated systems and transition energies, Woodward – Fieser rules; unsaturated carbonyl compounds, conjugated dienes and polyenes.

Unit-2	Number of lectures =08	Title of the unit: IR SPECTROSCOPY

Introduction, absorption in the infrared region, theory of infrared spectroscopy, instrumentation, molecular vibrations, factors affecting vibrational frequencies, characteristic absorptions in common classes of compounds, characteristic vibrational frequencies of some organic compounds.

Unit-3	Number of lectures = 08	Title of the unit: NMR SPECTROSCOPY

Introduction, theory of NMR spectroscopy, instrumentation, chemical shift, equivalent and nonequivalent protons, spin-spin splitting, vicinal coupling,, Interpretation of NMR spectra of some representative compounds.

Unit-4	Number of lectures = 08	Title of the unit: MASS SPECTROSCOPY

Introduction, basic theory, instrumentation, important useful terms in mass spectrometry, fragmentation patterns of various functional groups (alkanes, alkenes, alkynes, alcohols, ether, phenols and amines, ketones, aldehydes, esters, acids, anhydrides), molecular ion peak, metastable peak, Mclafferty rearrangements, Nitrogen rule.

Unit-5	Number of lectures = 08	Title of the unit: ATOMIC ABSORPTION SPECTROPHOTOMETRY

Introduction, Principle, Instrumentation, Sample preparation, Internal standard and standard addition, calibration and applications of AAS.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Understanding Wave-like propagation of light, electronic transitions, instrumentation, conjugated systems and transition energies, Woodward – Fieser rules for calculation of wave length.	**3**	**1**	**2**		**1**		**2**
CO2	Comprehension of absorption in the infrared region, theory of infrared spectroscopy, instrumentation, molecular vibrations, factors affecting vibrational frequencies, characteristic absorptions in common classes of compounds.	**3**	**1**	**2**		**1**		**2**
CO3	To create basics of NMR spectroscopy, instrumentation, chemical shift, equivalent and nonequivalent protons, spin-spin splitting and vicinal coupling.	**3**	**1**	**2**		**1**		**2**
CO4	Able to evaluate the NMR spectra of some representative compounds: Hydrocarbons, Aldehydes, Ketones, Acids and Alcohols, Applications of NMR spectroscopy.	**3**	**1**	**1**		**1**		**2**
CO5	Analyze the theory, instrumentation, important useful terms in mass spectrometry; molecular ion peak, metastable peak, fragmentation patterns of various functional groups (alkanes, alkenes, alkynes, alcohols, ketones, aldehydes), Mclafferty rearrangements.	**3**	**1**	**1**		**1**		**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=2Y8pSoS0d1g
2. http://www.infocobuild.com/education/audio-video-courses/chemistry/ApplicationOfSpectroscopicMethods-IIT-Madras/lecture-25.html
3. https://scrippslabs.com/summary-of-spectroscopic-techniques/
4. https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod2.pdf

13. Books recommended:

1. Introduction to spectroscopy: Pavia, Lampman & Kriz, 3rd Ed, Books/cole.
2. Spectroscopic methods in organic chemistry: H. Williams and Ian fleminig, V Edition Tata Mc Grawhills
3. Organic spectroscopy: William Kemp, 3rd Edition, Palgrave publications.
4. Fundamentals of Analytical chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, 7th edition, Harcourt college publications.
5. Principles and practice of analytical chemistry, F. W. Fifield, D. Kealey, 5th edition, Blackwell publication.
6. Analytical chemistry, Gary D. Christian, 6th edition, Wiley and sons publication.
7. Spectrometric identification of organic compounds, R. M. Silverstein, 6th edition, John Wiley and sons.
8. Basic concepts of analytical chemistry, S. M. Kopper, New Age International Publishers.

SEMESTER – VI

1. Name of the Department: CHEMISTRY						
2. Course Name	**CHEMICAL PROCESS INDUSTRY**			**L**	**T**	**P**
3. Course Code	**CH309**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. **COURSE OBJECTIVES:** The main objective of this course is to study the composition, preparation, properties and uses of ammonia, nitric acid, phosphorus chemical, glass, cement, ceramics and refractories and their related toxic hazards on the health of consumer.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Evaluate different preparation processes for the manufacture of ammonia, nitric acid, ammonium nitrate and ammonium sulphate and their related quality control, hazards, safety and effluent management.
CO2	Evaluate different manufacturing methods of caustic soda and phosphorus chemicals and their properties and uses.
CO3	Understand the composition of glass and their types, properties and uses.
CO4	Analyze the composition, types, properties and preparation of cement and its setting time.
CO5	Understand the classification, properties and uses of ceramics and refractories and their respective characteristics.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: SYNTHETIC NITROGEN PRODUCTS

Ammonia, nitric acid, ammonium nitrate and ammonium sulphate their manufacture with reference to; consumption Pattern, Raw materials, Production process, Quality control, Hazards and safety and Effluent management.

Unit-2	Number of lectures =08	Title of the unit: CHLOR – ALKALI INDUSTRIAL PRODUCTS

Caustic soda Chlorine. Phosphorus chemicals; Phosphorus, phosphoric acid, ammonium phosphate, superphosphate, triple superphosphate. Lime, gypsum, Silicon, calcium carbide.

Unit-3	Number of lectures = 08	Title of the unit: GLASS

Introduction, Classification and General Properties of Glass , Characteristics, raw Materials, Chemical Reactions, Methods of Manufacture and Uses.

Unit-4	Number of lectures = 08	Title of the unit: CEMENT

Introduction, Composition, Types of cement, Portland cement; raw Materials, manufacture of Cement by wet & Dry process, Reaction in the Kiln, setting of cement, Testing & Uses of cement.

Unit-5	Number of lectures = 08	Title of the unit: CERAMICS AND REFRACTORIES

Introduction, Types of ceramics materials, properties and applications. Refractories, classification of refractories, characteristics of refractories materials, properties of refractories. Neutral refractories; Silicon carbide. Acid refractories; High Alumina refractories.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Evaluate different preparation processes for the manufacture of ammonia, nitric acid, ammonium nitrate and ammonium sulphate and their related quality control, hazards, safety and effluent management.	**3**	**2**	**3**	**3**	**2**	**3**	**2**
CO2	Evaluate different manufacturing methods of caustic soda and phosphorus chemicals and their properties and uses.	**3**	**2**	**3**	**3**	**1**	**3**	**2**
CO3	Understand the composition of glass and their types, properties and uses.	**3**	**2**	**3**	**3**	**1**	**3**	**2**
CO4	Analyze the composition, types, properties and preparation of cement and its setting time.	**3**	**2**	**3**	**3**	**1**	**3**	**2**
CO5	Understand the classification, properties and uses of ceramics and refractories and their respective characteristics.	**3**	**2**	**3**	**3**	**1**	**3**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://encyclopedia2.thefreedictionary.com/chemical+process+industry
2. https://www.youtube.com/watch?v=RjZJjneJ5fk
3. https://www.chemicalprocessing.com/
4. https://www.britannica.com/science/phosphorus-chemical-element

13. Books recommended:

1. Shreve R.N. Brink. J.A., Chemical Process Industries, International student edition, Pubs: McGraw Hill Book Co. New York, 1960.
2. Groggins P.M., Unit Process in Organic Synthesis, 5th edition, International student edition, Pubs: McGraw-Hill Book Co., New York, 1998.
3. Dryden's outlines of Chemical Technology, edited and revised by Gopala Rao M. and Marshall S, Pubs: East-West Press, New Delhi, 2004.
4. Industrial Chemistry B.K.Sharma, goel publishing house.
5. Chemical process industries N.R Nerris shreve.
6. Chemical process principales: part 1 & II – O.A / Hougen, K.M Watson RA Ragatz (CBS)
7. Shrev's Chemical process Industries: 5th edition – George T. Austin, Mc Graw Hill.

SEMESTER – VI

1. Name of the Department: CHEMISTRY						
2. Course Name	**FUNDAMENTAL OF FOOD CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH310**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** The course focuses on providing knowledge of food constituents, food additives and food processing techniques. The study of food laws and standards appraise students about quality and safety assurance and food related hazards.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understanding of Indian food law and food standards, value of quality assurance and safety assurance
CO2	Comprehension of chemical structure, properties and argue importance of food components, including carbohydrates, protein, lipids, vitamins and minerals.
CO3	Describe the principles in food processing techniques and differentiate food preservation methods like heat preservation and cold preservation, food packaging
CO4	Able to explain different types of food additives with examples and judge its value in real life.
CO5	Analyze the importance of food safety and food related physical, chemical and biological hazards.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: GOVERNMENTAL REGULATIONS

Introduction, Food laws and standards: Indian food safety laws and standards; Quality and safety assurance in food industry; BIS Laboratory Services and Certification by BIS.

Unit-2	Number of lectures =08	Title of the unit: CONSTITUENTS OF FOOD AND THEIR NUTRITIVE ASPECTS

Carbohydrates, Proteins, Fats and oils, Vitamins and Minerals.

Unit-3	Number of lectures = 08	Title of the unit: FOOD PROCESSING TECHNIQUES

Common unit operations, Food deterioration and their control; Heat preservation and processing, Cold preservation and processing Food dehydration, Food concentration & food packaging.

Unit-4	Number of lectures = 08	Title of the unit: FOOD ADDITIVES

Preservatives, Antioxidants, Chelating agents, Surface active agents, Stabilizing and Thickening agents, Buffering agents, Colouring agents, Sweetening agents & Flavoring agents.

Unit-5	Number of lectures = 08	Title of the unit: FOOD SAFETY, RISKS AND HAZARDS

Food related Hazards, Microbiological Considerations in food safety, Effects of processing and storage on microbial safety, Chemical hazards associated with foods, Prevention methods from food born disease.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Understanding of Indian food law and food standards, value of quality assurance and safety assurance	**3**	**2**	**3**	**2**	**3**	**3**	**3**
CO2	Comprehension of chemical structure, properties and argue importance of food components, including carbohydrates, protein, lipids, vitamins and minerals.	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CO3	Describe the principles in food processing techniques and differentiate food preservation methods like heat preservation and cold preservation, food packaging	**3**	**2**	**2**	**2**	**3**	**3**	**3**
CO4	Able to explain different types of food additives with examples and judge its value in real life.	**3**	**2**	**2**	**2**	**3**	**3**	**3**
CO5	Analyze the importance of food safety and food related physical, chemical and biological hazards.	**3**	**2**	**3**	**3**	**3**	**3**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. http://www.basicknowledge101.com/pdf/Food%20chemistry.pdf
2. https://courses.foodcrumbles.com/courses/food-chemistry-basics/
3. https://www.cabdirect.org/cabdirect/abstract/19710406009
4. https://byjus.com/chemistry/food-chemistry/

13. Books recommended:

1. Food Chemistry, Belitz and Gosch, Springer – Verlag Bertin Heiderberg, 2nd Edition, 1999
2. Principles of Human Nutrition, Martin Eastwood, Chapman and Hall, London, I Edition, 1997.
3. Food – The Chemistry of its Components, T.P. Coultate, Royal Soc. Chemistry, 4th Edition, 2002.
4. Food additives, Branan, Alfred Larry, Davidson P. Michae, Food Science and Technology series (35), Morcel Dekker, Inc, 1990.
5. Introduction to food science, Rick Parker, Delmar Learning, U.S.A, I Edition, 2003.
6. Nutrition Science and application, Lori Smolin L.A., Saunders College Publishing, 3rd Edition.
7. Human Nutrition and dietetics, J.S. Barrow, W.P.T James, Churchill Livingstone, 9th Edition, 1993.

SEMESTER – VI

1. Name of the Department: CHEMISTRY						
2. Course Name	DAIRY CHEMISTRY			L	T	P
3. Course Code	CH311			3	1	0
4. Type of Course (use tick mark)				Core ( )	DE (√)	FC ( )
5. Pre-requisite (if any)	10+2 with Chemistry	6. Frequency (use tick marks)	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		Tutorials = 10		Practical = Nil		

8. **COURSE OBJECTIVES:** To introduce students to an understanding of the chemistry of milk constituents. Milk and various dairy products are discussed from the perspective of the chemical, physical and biological changes that occur during processing.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will be able to describe the composition of milk, identify the approximate content of individual types present
CO2	Students will integrate their knowledge of food chemistry and describe physicochemical characteristics of the main components.
CO3	Student will be able to explain how dairy products (such as fluid milk, yogurt, butter, powder, cheese) are made and the key functions of the processing steps involved.
CO4	Student will be able explain and apply the processing techniques to produce milk products such as butter, cream, ghee etc. and also detect the adulteration.
CO5	Students will integrate their knowledge of food chemistry to produce fermented milk products such as ice-creams milk powder etc.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: INTRODUCTION

Definition, Composition, Milk lipids, Milk proteins, vitamins and minerals. Factors affecting the composition of milk, adulterants, preservatives.

Unit-2	Number of lectures =08	Title of the unit: PROPERTIES OF MILK

Flavour and aroma, acidity, specific gravity, viscosity and conductivity. Estimation of fat, acidity and total solids in milk.

Unit-3	Number of lectures = 08	Title of the unit: PROCESSING OF MILK

Effect of heat on milk, chemical changes taking place in milk due to processing, sterilization, homogenization and pasteurization, vacuum pasteurization and Ultra high temperature pasteurization.

Unit-4	Number of lectures = 08	Title of the unit: MILK PRODUCTS

Cream; definition, chemistry of creaming process. Butter; definition, composition, theory of churning, desi-butter, salted butter. Ghee; major constituents, common adulterants and their detection.

Unit-5	Number of lectures = 08	Title of the unit: FERMENTAED MILK PRODUCTS

Fermentation of milk; definition and conditions. Ice-creams. Composition, types, manufactures of ice - cream, stabilizers, emulsifiers, and their role. Milk powder, process of making milk powder.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will be able to describe the composition of milk, identify the approximate content of individual types present	1	1	1	1	2	3	3
CO2	Students will integrate their knowledge of food chemistry and describe physicochemical characteristics of the main components.	2	1	1	1	3	2	3
CO3	Student will be able to explain how dairy products (such as fluid milk, yogurt, butter, powder, cheese) are made and the key functions of the processing steps involved.	3	1	1	1	2	3	3
CO4	Student will be able explain and apply the processing techniques to produce milk products such as butter, cream, ghee etc. and also detect the adulteration.	1	1	1	1	2	2	2
CO5	Students will integrate their knowledge of food chemistry to produce fermented milk products such as ice-creams milk powder etc.	1	1	1	1	2	2	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=S4brYhScYlc
2. http://ouat.nic.in/sites/default/files/2-properties_of_milk_dairy_and_food_engineering.pdf
3. https://www.youtube.com/watch?v=iAaRs4vM8x8
4. https://www.youtube.com/watch?v=QvSw68wJpqw

13. Books recommended:

1. Applied Chemistry-K.Bagavathi Sundari MJP Publishers Chennai. 2006.
2. Principles of dairy technology - Robert Jenness
3. Indian Dairy Products - Rangappa and Acharya, K.T.
4. Fundamentals of Dairy chemistry - Wond. F.P. Springer.
5. Outlines of Dairy Technology - Sukumar De. – Oxford University Press.
6. Applied chemistry for home science & allied science - T.Jacob, Mcmillan.

SEMESTER – VI

1. Name of the Department: CHEMISTRY						
2. Course Name	**PROJECT TRAINING (3 MONTHS)**			**L**	**T**	**P**
3. Course Code	**CH312**			0	0	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		
8. **COURSE OBJECTIVES:** The main objective is to enhance the technical skills and to provide students industrial exposure.						
9. COURSE OUTCOMES (CO): ***After the successful course completion, learners will develop following attributes:***						

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Hands on training
CO2	Integrate classroom theory with laboratory scale practice.
CO3	Understanding professional ethics of industry and code of conduct.

10. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Hands on training	**3**	**2**	**3**	**2**	**3**	**3**	**3**
CO2	Integrate classroom theory with laboratory scale practice.	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CO3	Understanding professional ethics of industry and code of conduct.	**3**	**2**	**2**	**2**	**3**	**3**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

1. Name of the Department: CHEMISTRY				
2. Course Name	**ORAL PRESENTATION**	**L**	**T**	**P**
3. Course Code	**CH313**	0	0	8