CHEMISTRY FOR CHEMICAL ENGINEERS **Course Code : 313016**

Programme Name/s : **Chemical Engineering**
Programme Code : **CH**
Semester : **Third**
Course Title : **CHEMISTRY FOR CHEMICAL ENGINEERS**
Course Code : **313016**

I. RATIONALE

The fundamental ideas behind many chemical processing systems are covered in Physical Chemistry which includes the phase rule, adsorption, colloids, and numerous characteristics. To strengthen the experimental abilities needed in the laboratory and chemical processing units, fundamental ideas like concentration and solution behavior are covered. Organic compounds occur naturally in great abundance on Earth and they constitute the various chemicals used in Chemical Engineering fields like petrochemicals, pharmaceuticals, food, agrochemicals, biochemistry, biotechnology, plastics, polymers, rubber, textile, paper and pulp, cosmetics etc. The course emphasizes the important concepts like the structure, nomenclature properties, composition, reactions and preparation of carbon-containing compounds.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified outcome through various teaching learning experiences: Select the suitable organic compounds for various processes in Chemical Industries.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply the adsorption principle in the operations of purification and separation
- CO2 - Apply the colloidal system and phase diagram concepts
- CO3 - Identify the nomenclature and structure of organic compounds
- CO4 - Identify the various preparation techniques and characteristics of Aliphatic &Aromatic compounds
- CO5 - Identify the various properties and methods of preparation for alcohols, phenols, and carboxylic acids.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313016	CHEMISTRY FOR CHEMICAL ENGINEERS	CCE	DSC	2	-	2	2	6	3	-	-	-	-	-	25	10	25@	10	25	10	75

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the concept and mechanism of adsorption. TLO 1.2 Enlist the types of adsorptions. TLO 1.3 Explain the adsorption isotherm. TLO 1.4 Enlist the applications of adsorption in process industries.	**Unit - I Adsorption** 1.1 Adsorption: Definition, example, Mechanism of adsorption 1.2 Types of adsorptions Physical adsorption, chemical adsorption, difference between physical & chemical adsorption 1.3 Adsorption isotherm: • Freundlich adsorption isotherm. • Langmuir adsorption isotherm 1.4 Application of adsorption	Chalk-Board Method Audio video Demonstration Site/Industry Visit Guest Lecture
2	TLO 2.1 Enlist the types of colloidal system TLO 2.2 Explain the methods of preparation of colloids TLO 2.3 Explain the concept of phase rule. TLO 2.4 Calculate the degree of freedom of given system TLO 2.5 State the concept of phase diagram for different systems. TLO 2.6 State the Concept of Nerst Distribution law.	**Unit - II Heterogeneous System** 2.1 Colloids: Definition. Types of colloidal system: • Lyophilic. • Lyophobic colloids (solution) Characteristics & its comparison 2.2 Methods of preparation of colloids. • Dispersion method 2.3 Phase rule: Statement, Phase components. 2.4 Degree of freedom 2.5 Derivation of phase rule, phase diagram for water system, sulphur system. 2.6 Nerst Distribution Law (concept) and its application.	Chalk-Board Method Audio video Demonstration Site/Industry Visit Guest Lecture

CHEMISTRY FOR CHEMICAL ENGINEERS **Course Code : 313016**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain the concept of Hybridization. TLO 3.2 Classify organic compounds based on functional groups. TLO 3.3 Explain the IUPAC Nomenclature for Organic Compounds.	**Unit - III Chemistry of Organic Compounds** 3.1 Chemical bonding in Carbon atom, and Hybridization: sp, sp2 and sp3 and characteristics of chemical compounds. 3.2 Classification based on functional group: Hydrocarbons, Alcohol, carboxylic acid, Ether, Esters, aldehyde, ketone 3.3 Nomenclature of Organic Compounds: Common/trivial names and IUPAC Nomenclature	Chalk-Board Method Audio video Demonstration Site/Industry Visit Guest Lecture

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Identify the methods of preparations and chemical reactions of Alkanes. TLO 4.2 Identify the methods of preparations and chemical reactions of Alkenes. TLO 4.3 Identify the methods of preparations and chemical reactions of Alkynes. TLO 4.4 Identify the methods of preparations and chemical reactions of Aromatic compounds.	**Unit - IV Aliphatic & Aromatic Compounds** 4.1 Aliphatic Compounds: Alkanes, Alkenes and Alkynes Alkanes: Isomerism in alkanes. Methods of Preparation: • From unsaturated hydrocarbons, • Wurtz Coupling reaction. Chemical reactions • Halogenation of alkanes • Combustion • Pyrolysis. Physical properties and uses. 4.2 Alkenes: Isomerism in alkenes Methods of Preparation: • By elimination reaction (dehydrohalogenating of alkyl halides, dehydration of alcohols) • Addition reactions Chemical reactions: • Addition of hydrogen halides (Markovnikov's rule and anti- Markovnikov's rule) • Addition of sulphuric acid • Oxidation. Physical properties and uses. 4.3 Alkynes: Isomerism Methods of Preparation: • By dehydrohalogenation of vicinal dihalides. Chemical Reactions: • Addition of dihydrogen. • Addition of halogens. • Addition of hydrogen halides. Physical properties and uses. 4.4 Aromatic compounds: Introduction, IUPAC nomenclature; benzene; resonance aromaticity. Methods of preparation of benzene: • From aromatic acids • By hydrolysis of sulphuric acid with superheated steam. Chemical Reactions: • Mechanism of electrophilic substitution- nitration, sulphonation, halogenation, • Friedel Craft alkylation. Physical properties and uses	Chalk-Board Method Audio video Demonstration Site/Industry Visit Guest Lecture

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Identify the methods of preparations and chemical reactions of Alcohols TLO 5.2 Identify the methods of preparations and chemical reactions of Phenols TLO 5.3 Identify the methods of preparations and chemical reactions of Carboxylic acids.	**Unit - V Alcohols, Phenols and Carboxylic acids** 5.1 Alcohols: Nomenclature, Classification of alcohols Methods of preparation: • By Grignard synthesis of alcohol. • Reduction of ethylene oxide. Chemical reactions: • With hydrogen halides • With active metals. • With carboxylic acids. Physical properties and uses. 5.2 Phenols: Nomenclature Methods of preparation: • By hydrolysis of diazonium salt. Chemical reactions: • Acidic nature of phenol. • Formation of ethers (Williamson Synthesis). • Kolbe reaction. • Reimer-Tiemann reaction Physical properties and Uses 5.3 Carboxylic acids: Nomenclature, acidic nature. Methods of preparation: • From primary alcohol • Alkylbenzenes. Physical properties and Uses Chemical reactions: • Conversion to acid chloride. • Conversion into esters. • Reduction to alcohols.	Chalk-Board Method Audio video Demonstration Site/Industry Visit Guest Lecture

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Plot a graph of Freundlich isotherm . LLO 1.2 Find the value of adsorption constant K and slope n.	1	*Determine Freundlich Adsorption Isotherm of Acetic acid on Activated Charcoal.	2	CO1
LLO 2.1 Plot a graph of Freundlich isotherm. LLO 2.2 Find the value of adsorption constant K and slope n.	2	Determine Freundlich Adsorption Isotherm of Oxalic acid on Activated Charcoal.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Plot a graph of Langmuir isotherm. LLO 3.2 Find the value of adsorption constant K and slope n.	3	Determine Langmuir Adsorption Isotherm of Acetic acid on Activated charcoal.	2	CO1
LLO 4.1 Plot a graph of Langmuir isotherm. LLO 4.2 Find the value of adsorption constant	4	*Determine Langmuir Adsorption Isotherm of Oxalic acid on Activated charcoal.	2	CO1
LLO 5.1 Select the raw material for Lyophobic Sol.	5	Prepare Lyophobic Sol of Ferric hydroxide.	2	CO2
LLO 6.1 Select the raw material for Lyophilic Sol.	6	*Prepare Lyophilic Sol (Colloids) of Starch.	2	CO2
LLO 7.1 Find the melting point & Eutectic temperature	7	Find the melting point and Eutectic temperature and construct a phase diagram for binary system. (Naphthalene and Benzoic acid)	2	CO2
LLO 8.1 Select the raw material to find partition coefficient.	8	*Find the Partition Coefficient (K) .	2	CO2
LLO 9.1 Find the purity of a given solid compound.	9	*Determine melting point of an organic compound. (p-toluidine, naphthalene, oxalic acid, ?-naphthol, resorcinol, benzoic acid.)	2	CO3
LLO 10.1 Find the purity of a given liquid compound.	10	Determine the boiling point of an organic compound. (acetone, methyl acetate, acetic acid, xylene)	2	CO3
LLO 11.1 Measure the physical constant of a given chemical substance. LLO 11.2 Detect the element like N,H & S in a given chemical substance. LLO 11.3 Detect the functional group of chemical substance.	11	*Determine the given Organic Compound by Organic Qualitative Analysis: (Chlorobenzene /Alpha or Beta naphthalene).	2	CO4
LLO 12.1 Measure the physical constant of a given chemical substance LLO 12.2 Detect the element like N,H & S in a given chemical substance. LLO 12.3 Detect the functional group of chemical substance.	12	Determine the given Organic Compound by Organic Qualitative Analysis: (Chloroform).	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Measure the physical constant of a given chemical substance. LLO 13.2 Detect the element like N,H & S in a given chemical substance. LLO 13.3 Detect the functional group of chemical substance.	13	Determine the given Organic Compound by Organic Qualitative Analysis: (Nitrobenzene).	2	CO4
LLO 14.1 Measure the physical constant of a given chemical substance. LLO 14.2 Detect the element like N,H & S in a given chemical substance. LLO 14.3 Detect the functional group of chemical substance.	14	*Determine the given Organic Compound by Organic Qualitative Analysis: (Methanol/Ethanol)	2	CO5
LLO 15.1 Measure the physical constant of a given chemical substance. LLO 15.2 Detect the element like N,H & S in a given chemical substance LLO 15.3 Detect the functional group of chemical substance.	15	Determine the given Organic Compound by Organic Qualitative Analysis: (Resorcinol/ salicylic acid).	2	CO5
LLO 16.1 Measure the physical constant of a given chemical substance. LLO 16.2 Detect the element like N,H & S in a given chemical substance. LLO 16.3 Detect the functional group of chemical substance.	16	*Determine the given Organic Compound by Organic Qualitative Analysis: (Benzoic acid/Acetic acid)	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- 1. Prepare a chart of IUPAC Nomenclature Rules.

2. Enlist the raw materials for preparation of alkanes, alkenes and alkynes. .
3. Enlist the industrial applications of Alcohols, Phenols and Carboxylic acids. .
4. Enlist various industrial applications and uses of Adsorption. .
5. Prepare a detailed report on Methods of Preparation of colloids by Bredig's Arc Method. .
6. Prepare a detailed report on Methods of Preparation of: .
• Alkane from alkyl halides. .
• Alkene by dehalogenation of vicinal dihalides. .
• Alkynes from terminal dihalides. .
• Aromatic compounds by action of alkyl halides. .
7. Prepare a detailed report on Methods of Preparation of: .
• Alcohol from reduction of aldehyde and ketones. .
• Phenol by alkali fusion of sulphonates. .
• Carboxylic acid from Grignard reagent, nitriles.
8. Write Chemical reactions for following: .
• Nitration of Alkanes. .
• Ozonolysis of alkenes. .
• Addition of water with alkynes. .
• Acylation reaction of Aromatic compounds .
9. Write Chemical reactions for following: .
• Dehydration of alcohols. .
• Formation of esters from Phenol. .
• Decarboxylation of Carboxylic acid.

Micro project

- 1. Use Labster's Organic Chemistry introduction virtual lab, for interactive simulation, for practice chemical tests for identifying functional groups in a hazard-free environment.

2. Enroll for NPTEL Courses on" Basic Organic Chemistry/ Introductory Organic Chemistry I"
3. Write different chemical reactions along with the structures using "ChemSketch "Software.
4. Highlight the significance of Organic Chemistry in today's world like pharmaceuticals,petrochemicals,agrochemicals,polymers,plastics,cosmetics ,foods etc.
5. Make 3D Molecular Models using Styrofoam balls

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Conical Flask (250ml)	1,2,3,4,5,6,7,8

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	Burette (50ml), Pipette (25ml)	1,2,3,4,5,6,7,8
3	Burette Stand	1,2,3,4,5,6,7,8,9,10
4	Water bath	1,2,3,4,9,10
5	Test Tubes	11,12,13,14,15,16
6	Filter Paper	11,12,13,14,15,16
7	Test tube holder	11,12,13,14,15,16
8	Crucible (50 ml)	11,12,13,14,15,16
9	Separating funnel (250ml)	8
10	Thiele Tube (Diameter of tube:25mm, length 150 mm)	9,10
11	Capillary tube	9,10,11
12	Fusion Tube	9,10,11,12,13,14,15,16
13	Melting Point Apparatus: Two Melting Standards 49 degree Celsius and 238 degree Celsius Power Cord	9,10,11,12,13,14,15,16
14	Thermometer (0 to 100 degree Celsius and 0 to 360 degree Celsius)	9,10,11,12,13,14,15,16
15	Beakers(50ml, 100ml and 500 ml)	All
16	Glass Rod	All
17	Glass Bottles (500 ml)	All
18	Weighing Balance (Digital Display, 300 g, Sensitivity. 0.01 g)	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Adsorption	CO1	4	0	0	0	0
2	II	Heterogeneous System	CO2	6	0	0	0	0
3	III	Chemistry of Organic Compounds	CO3	6	0	0	0	0
4	IV	Aliphatic & Aromatic Compounds	CO4	7	0	0	0	0
5	V	Alcohols, Phenols and Carboxylic acids	CO5	7	0	0	0	0
Grand Total				**30**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- • End Semester Practical Examination • Term Work as Continuous Assessment.

Summative Assessment (Assessment of Learning)

XI. SUGGESTED COS - POS MATRIX FORM

CHEMISTRY FOR CHEMICAL ENGINEERS **Course Code : 313016**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	1	1	1	1	2			
CO2	2	1		1	1	1	2			
CO3	2	-	1	1	2	1	2			
CO4	2	-	1	1	2	1	2			
CO5	2	-	1	1	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	B. S. Bahal, G. D. Tuli, Arun Bahal	Essential of Physical Chemistry	S. Chand ISBN -13 ,978-8121905466
2	B.R.Puri, L.R.Sharma, Madan s, Puthania	Principles of Physical Chemistry	S. Chand Publication ISBN -13 978-9382956013
3	Morrison Boyd & Bhattacharjee	Organic Chemistry	Pearson Education ISBN 9788131704813
4	Bahl Arun, Bahl B.S.	A Textbook of Organic Chemistry	S. Chand ISBN -13 ,978-9352531967

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.coursera.org/learn/physical-chemistry	Introduction to Physical Chemistry
2	https://www.coursera.org/learn/basic-chemistry	Introduction to Organic Chemistry
3	https://www.coursera.org/learn/high-throughput	Physical Chemistry
4	https://www.digimat.in/nptel/courses/video/104106119/L06.html	NPTEL Video :Introduction to Organic Chemistry{Alkanes,Cycloalkanes)
5	https://youtu.be/0UfMcbSOteo?si=AATnwjIgOckCs6hQ	NPTEL/IISER Video on Applications of Organic Compounds in various fields.
6	https://youtu.be/sq_qod2UNVI?si=ht4erQ5pBbm2e-_U	Swayam Video on Basic Principles of Organic Chemistry
7	https://youtu.be/Cc5NltNuOBE?si=UuntFcxfyGBmFXH6	Swayam Video on Organic compounds :Structure,reactions,preparations
8	https://youtu.be/2LywAiZBQW4?si=mo_NVyXl_kAPHXbz	NPTEL video: Phase Rule

CHEMISTRY FOR CHEMICAL ENGINEERS **Course Code : 313016**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students