

Programme Name/s : Chemical Engineering

Programme Code : CH

Semester : Second

Course Title : FUNDAMENTAL OF CHEMICAL ENGINEERING & MATERIALS

Course Code : 312341

I. RATIONALE

This course is designed with an objective of stating the job role performed by a chemical engineer and develop an ability to understand basic terminologies used, operations carried out, safety aspects, basic measurement and calculations done on a daily basis in chemical industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Chemical engineering student will be conversant with terminologies used and duties of chemical engineer.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Enumerate the role & responsibility of chemical engineer.
- CO2 - Use different safety norms, symbols for performing various safe operations/processes in given Chemical industry
- CO3 - Prepare the solution of given molarity/molality/normality for chemical reaction.
- CO4 - Select the relevant unit operations and unit processes for given chemical industry.
- CO5 - Select suitable material of construction for relevant chemical process.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TL				Based on SL						
				CL	TL	LL			FA-TH			SA-TH	Total		FA-PR		SA-PR		SLA			
													Max	Min	Max	Min	Max	Min	Max	Min		
312341	FUNDAMENTAL OF CHEMICAL ENGINEERING & MATERIALS	FCEM	DSC	3	-	4	1	8	4	3	30	70	100	40	50	20	25@	10	25	10	200	

Total IKS Hrs for Sem. : 2 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	<p>TLO 1.1 Provide an overview and evolution of chemical engineering.</p> <p>TLO 1.2 Apply broad criteria for the classification of types of chemicals and chemical industries.</p> <p>TLO 1.3 Choose nature of the job to be performed by a chemical engineer.</p>	<p>Unit - I Introduction to Chemical Engineering</p> <p>1.1 Chemical Engineering : History and evolution in India (Brief review about ancient , pre and post independence chemical industry in India (Contribution of Nagarjuna, Contribution of P.C. Ray - The father of Indian Chemical Industry)(IKS) - Chemistry vs Chemical Engineering</p> <p>1.2 Classification of chemical industry on the basis of : i.Type of chemical manufactured (Bulk, fine and specialty chemical) Difference between bulk, fine and specialty chemicals. ii. Type of product manufactured (Pharmaceutical, Paint industry, fertilizer industry, Chlor- alkali. Polymer, Paper & Pulp, industry, etc..)</p> <p>1.3 Job roles and job opportunities available to chemical engineers.</p>	<p>Chalk-Board Video Demonstrations Presentations</p>
2	<p>TLO 2.1 Develop Safety consciousness by explaining the importance of safety.</p> <p>TLO 2.2 Use GHS and NFPA symbols for hazard identification.</p> <p>TLO 2.3 Select the appropriate type of fire extinguisher for given class of fire.</p> <p>TLO 2.4 Select appropriate PPE for given situation.</p> <p>TLO 2.5 Select the relevant First aid methods.</p>	<p>Unit - II Safety in Chemical Laboratory</p> <p>2.1 Safety: Importance of Safety in a Chemical laboratory and Standard Safety Instructions.</p> <p>2.2 Hazard and Hazard communication: GHS Hazards symbols for Biohazard, Toxic, Corrosive , Environment , oxidizer and Flammable material. Understand and interpret the hazard as per National Fire Protection Association(NFPA) hazard diamond(symbol).</p> <p>2.3 Fire: Definition of fire, fire triangle, classification of fire and standard method of using fire extinguisher.</p> <p>2.4 PPEs used in chemical laboratories. (Apron, Helmet, Face Shield, Safety Goggle, Ear Plug, Ear Muff, Hand Gloves, Safety Shoes).</p> <p>2.5 First aid measures in chemical laboratory: First aid measures in case of eye injury, burn, skin contact and inhalation of toxic fumes.</p>	<p>Chalk-Board Model Demonstration Video Demonstrations Hands-on Role Play</p>
3	<p>TLO 3.1 Provide chemical engineering perspectives about properties of solutions.</p> <p>TLO 3.2 Prepare solution of known concentration/composition.</p> <p>TLO 3.3 Explain the concept of pH , electrical conductivity and its measurement.</p> <p>TLO 3.4 Calculate the density/Specific gravity of given solution and its relation with composition of solution.</p> <p>TLO 3.5 Equip the chemical engineer with basic skills related to solution preparation.</p>	<p>Unit - III Basic Properties of solution and Chemical Calculation</p> <p>3.1 Commonly used physical properties of solutions. Concepts/definition and applications. Examples of instruments used for measurement</p> <p>3.2 Basic chemical calculations: Concentration and methods of expressing concentration of solutions such as strength (g/l) Molarity, Molality and Normality. Numerical based on topic.</p> <p>3.3 Composition of mixture on weight basis(wt%) and mole basis (mol%) basic numerical.</p> <p>3.4 pH & pH scale , density, specific gravity, viscosity, electrical conductivity, solubility, Partial pressure and vapour pressure, Dry bulb Temperature and Wet Bulb temperature.</p> <p>3.5 Specific gravity measurement using specific gravity bottle and hydrometer.</p>	<p>Chalk-Board Case Study Model Demonstration Hands-on</p>
4	<p>TLO 4.1 Identify the type of unit operations.</p> <p>TLO 4.2 Identify the mechanical operation in a given situation.</p> <p>TLO 4.3 Explain the concept of fluid flow operations and</p>	<p>Unit - IV Unit Operations and Unit Processes</p> <p>4.1 Unit Operations: Definition and classifications Symbols as per IS3232.</p> <p>4.2 Introduction to Mechanical operation and equipment's used(example only) Size reduction, Size separation - Screen Filtration, sedimentation</p>	<p>Chalk-Board Model Demonstration Video Demonstrations Case Study</p>

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.
	equipment used. TLO 4.4 Describe concept and application of different Heat and Mass transfer operations. TLO 4.5 Provide overview about different unit processes used in chemical process industries.	and mixing. 4.3 Concept of Fluid Flow Operation and equipments used for transportation of fluids (Examples only) . 4.4 Heat and Mass Transfer Operation: Modes of heat transfer operation, Evaporation, Gas absorption, Extraction. Distillation, Drying, Crystallization. 4.5 Unit Processes : Brief information and applications of unit processes like - Sulphonation, Oxidation, Reduction, Hydrogenation, Saponification, Esterification, Nitration, Halogenation and Cracking/pyrolysis.	Site/Industry Visit
5	TLO 5.1 Explain different properties of engineering material TLO 5.2 Enlist the criteria for selection of material used in process industries. TLO 5.3 Provide overview about common materials of construction used and their typical applications.	Unit - V Material of Construction for Chemical Process Industries 5.1 Important Properties of material such as ductility, malleability, tensile strength, corrosion resistance, stress strain curve, allowable or permissible stress and factor of safety. 5.2 Criteria for selecting material of construction 5.3 Description and applications of following material of constructions used in process industries Carbon steel Stainless steel Titanium Hastelloy Polymeric materials like Polypropylene, teflon(PTFE), Low density polyethylene, high density polyethylene, FRP.	Chalk-Board Presentations Case Study

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 Enlist different types chemicals used in laboratory. LLO 1.2 Describe typical technical specifications and grades of chemicals used.	1	Prepare a list of chemicals available in the chemical lab consisting of details like manufacture , Grade of chemical (LR/AR/HPLC) % Purity, Specific gravity, CAS no. and chemical formula.	4	CO1
LLO 2.1 Identify hazard by referring given GHS symbol.	2	* Categorize hazard for given chemicals using the GHS symbols.	4	CO2
LLO 3.1 Identify given class of fire. LLO 3.2 Select appropriate fire extinguisher for given situation.	3	* Demonstrate the use of fire extinguishers available in the laboratory.	4	CO2
LLO 4.1 Select appropriate Personal Protective equipment.	4	Demonstrate the use of personal protective equipments.	4	CO2
LLO 5.1 Describe the concept of molarity to estimate the quantities of solute required. LLO 5.2 Prepare the solution of required molarity by following standard procedure. LLO 5.3 Calculate the molarity of given solution by following standardization procedure.	5	* Prepare and standardize a solution of given molarity.	4	CO3
LLO 6.1 Explain the concept of normality to estimate the quantities of solute required. LLO 6.2 Prepare solution of	6	* Prepare and standardize the solution of given Normality.	4	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
given normality by following standard procedure. LLO 6.3 Calculate normality of solution by following standardization procedure.				
LLO 7.1 Explain the concept of molality to estimate the quantities of solute and solvent required. LLO 7.2 Prepare solution of given molality by following standard procedure. LLO 7.3 Calculate molality of solution by following standardization procedure.	7	Prepare and standardze the solution of given Molality.	4	CO3
LLO 8.1 Explain the concept of pH. LLO 8.2 Demonstrate the process of pH measurement using pH meter. LLO 8.3 Calculate the pH by adjusting acidity or alkalinity of solution.	8	* Prepare solution of given pH.	4	CO3
LLO 9.1 Measure concentration of given salt solution. LLO 9.2 Use conductivity meter for measuring electrical conductivity of a solution.	9	Prepare the salt solution of various concentrations to measure electrical conductivity.	4	CO3
LLO 10.1 Explain the concept of density/specific gravity. LLO 10.2 Measure density/specific gravity of given solution by using specific gravity bottle/hydrometer.	10	* Calculate the density of a given liquid by using a specific gravity bottle/hydrometer.	4	CO3
LLO 11.1 Explain the concept of DBT and WBT. LLO 11.2 Describe construction and working of sling psychrometer. LLO 11.3 Use sling psychrometer for measuring DBT and WBT.	11	* Measure DBT and WBT using a sling psychrometer to study the effect of ambient condition.	4	CO3
LLO 12.1 Explain the concept of size separation by using screening. LLO 12.2 Use screening operation for separating given sample as per particle size range.	12	Calculate particle size distribution in a given sample by using screen analysis.	4	CO4
LLO 13.1 Explain the concept of saturation solubility. LLO 13.2 Prepare saturated solution of given solute and determine saturation solubility.	13	* Use given salt to prepare saturated solution.	4	CO4
LLO 14.1 Explain the concept of leaching operation. LLO 14.2 Demonstrate the leaching operation.	14	* Calculate % recovery of dye from beet root or other substrate by leaching operation.	4	CO4
LLO 15.1 Explain the concept of corrosion. LLO 15.2 Measure the rate of	15	* Calculate the rate of corrosion in acidic/alkaline /Saline medium.	4	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
corrosion in different environment.				
LLO 16.1 Explain the effect of medium on rate of corrosion. LLO 16.2 Describe the concept of corrosion resistance of the material.	16	Calculate the corrosion resistance of different materials in the same acidic/alkaline/salt solution.	4	CO5
Note : Out of above suggestive LLOs -				
<ul style="list-style-type: none"> • '*' 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)

Micro project

- Suggested Microprojects 1.Prepare report about history and evolution of chemical engineering in India.
- 2. Prepare microproject report about contribution of Nagarjuna/ Acharya P. C. Ray in the field of Chemical science.
- 3.Find out the advertisement related to opportunity to work in PSU and MNC(min 50 advertisement expected),Prepare report.
- 4. Use online cross word making tool and prepare cross word or identified topic in a curriculum.
- 5. Take interview of chemical engineer or entrepreneur and write report based on your activity. You may take online interview.
- 6.Prepare report demonstrating different unit processes and typical products manufactured using the unit process selected.
- 7. *Identify the most commonly used basic, fine and specialty chemicals. Write their physical and chemical properties and list their application in details. - It is expected that pictures which depicts properties, application and special features of the chemicals must be used. It is also advisable to highlight the inventor of the products mentioned.
- 8. Study any two industrial accidents; prepare detail report about the process carried out, cause of accidents and consequences. Also mention what precaution should have been taken to avoid the accident.
- 9. Prepare a report or eBook or presentation about chemicals used in day to day life and typical chemical ingredients present in it.
- 10. Prepare the list of fire extinguisher available in your institute. Write the specification and application procedure.
- 11. Prepare chart which depicts the GHS symbol and their interpretation.
- 12. Prepare a list of chemical products used in daily life, their typical application and chemical composition.

Self Learning activity

- 1. Visit agrochemical shop in your area and prepare list of typical chemicals used in farming activity.
- 2. Visit the website of government companies/organization ONGC/ HPCL/IOCL /BARC/ Mangalore refinery. Prepare profile of industry including the capacity, type of products manufactured, typical chemical processing operation, opportunity to chemical engineers.
- 3. Prepare list of Chemical engineers who have received Padma Vibhushan, Padma Bhushan and Padmashri award. Mention their contribution to field of chemical engineering.
- 4. Visit the website of National Chemical Laboratory. Try to understand the typical kind of work carried and their typical achievements.
- 5. Visit the website of Ministry of Chemicals and fertilizers. Prepare report on points interested to chemical engineers.
- 6. Select any 10 manufacturing process. Identify the unit operations and unit processes involved into it.
- 7. Refer any magazine like chemical weekly, chemical industry digest, Chemical Engineering world . Read any topic of your interest and prepare report based on it.
- 8. Search web references which might be useful to chemical engineers and prepare report on it.
- 9. Prepare presentation/video depicting history of chemical engineering in India.
- 10. Prepare list of government companies which employ chemical engineers.
- 11. Prepare a model related any topic given in curriculum.
- 12. Prepare presentation based on chemical used in daily life.
- 13. Prepare presentation based on personal protective equipment's to be used in laboratory.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Fire extinguisher Dry Chemical powder type (Suitable for Class ABC)Water type Fire extinguisher (Suitable for Class A)Foam type fire extinguisher (Suitable for class B)CO2 type fire extinguisher.	3
2	Acid and alkali Proof hand gloves	1,4,5,6,7,8,15,16
3	Ear Muff and Ear Plug	4
4	Face shield	4
5	Safety Helmet	4
6	Safety Shoes	4
7	Pair of Tongue	15,16
8	pH meter with Calibration arrangement Suitable for 0-14 pH range and Temperature compensating and calibration arrangement.	8
9	pH paper and Universal pH indicator with pH scale chart for comparison	8
10	Buffer solutions 4 , 7 and 9.2 pH	8
11	Electrical Conductivity meter with calibration arrangement suitable for mV as well as conductance measurement.	9
12	Specific Gravity Bottle with stopper (25 mL/50 mL /100 mL)	10
13	Hydrometer (Density (g/cc) range 1 to 2) Hydrometer for Petroleum product	10
14	Sling psychrometer or Whirling hygrometer (0 to 50 C range)Body material : Plastic or wood	11
15	Sieve Shaker with set of standard sieves or set of standard screens.	12
16	Magnetic stirrer with speed regulator heating arrangement	13
17	Weighing balance (1 mg accuracy)	All
18	Weighing balance (1 mg accuracy)	All
19	Apron	All
20	Splash/Safety Goggles	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	Introduction to Chemical Engineering	CO1	6	2	4	2	8
2	II	Safety in Chemical Laboratory	CO2	5	2	4	4	10
3	III	Basic Properties of solution and Chemical Calculation	CO3	12	4	8	8	20
4	IV	Unit Operations and Unit Processes	CO4	12	4	8	8	20
5	V	Material of Construction for Chemical Process Industries	CO5	10	4	4	4	12
Grand Total				45	16	28	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each practical will be assessed considering - 60 % weightage to process, 40 % weightage to product

Summative Assessment (Assessment of Learning)

- End of term examination, Lab performance, Viva-Voce

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes	Programme Outcomes (POs)	Programme Specific
-----------------	--------------------------	--------------------

(COs)	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	Outcomes* (PSOs)		
								PSO-1	PSO-2	PSO-3
CO1	03	03	02	01	03	03	02			
CO2	03	03	01	-	01	02	02			
CO3	03	01	-	02	01	-	01			
CO4	03	03	02	-	02	01	01			
CO5	02	01	01	-	01	01	01			

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	S.K. Ghoshal, S.K. Sanyal, S.Datta	Introduction to Chemical Engineering	McGraw Hill Education ISBN 0-07-460140-7
2	S.N.Saha	Fundamentals of Chemical Engineering	Dhanpat Rai Publication, ISBN 81-87433-55-8
3	Bureau of Indian Standards	IS 3232: Recommendations on Graphical Symbols for Process Flow Diagrams, Piping and Instrumentation	Bureau of Indian Standards , Second Edition,1999
4	W.L. McCabe , J. C. Smith and Peter Harriot	Unit Operations of Chemical Engineering	McGraw Hill Higher Education ISBN 007-124710-6
5	P.H.Groggins	Unit Processes in Organic Synthesis	McGraw-Hill, New York
6	S.S.Mankar	Safety Legislations in Chemical Handling and Industries	Revised edition 2004 Published by Jyoti Mankar , New Panvel-401206
7	P.C.Jain, Monika Jain	Engineering Chemistry	Dhanpat Rai Publishing Company ISBN 978-93521600
8	Arun Bahl and B.S.Bahl	A Textbook of Organic Chemistry	S.Chand ISBN -978-9352531967
9	M.V.Joshi ,V.V.Mahajani	Process Equipment Design	McMillan India Ltd. SBN 0333924185

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://pubs.acs.org/doi/10.1021/ba-1980-0190.ch013	A History of Chemical Technology and Chemical Engineering in India (IKS)
2	https://www.cdc.gov/niosh/npg/	NIOSH POCKET GUIDE TO CHEMICAL HAZARDS
3	https://www.aiche.org/sites/default/files/cep/20181249.pdf	India's expanding Chemical Industry by J.B. Joshi and Ravi Raghvan (Chemical Engineering Progress, P
4	https://www.protank.com/sulfuric-acid#:~:text=Sulfuric%20Acid%20Storage%20Tanks%20are,stored%20out%2	Material of construction for storage of chemicals
5	https://www.ddpsinc.com/blog/material-of-construction-option-s-for-chemical-process-plants	Material of Construction Options for Chemical Process Plants
6	https://www.hse.gov.uk/comah/sragtech/techmeasmaterial.htm	Corrosion and selection of material
7	https://archive.org/details/gov.in.is.3232.1999	IS3232 :RECOMMENDATIONS~ON GRAPHICAL

Sr.No	Link / Portal	Description
		SYMBOLS FOR PROCESS FLOW DIAGRAMS, PIPING AND INSTRUMENTATION D
8	https://chemicals.gov.in/	Ministry of Chemicals and Fertilizers
9	https://doi.org/10.1007/978-94-009-2307-2_9	Chemical Engineering Developments in India by Ragunath Mashelkar and J.V.Rajan