SAFETY IN CHEMICAL INDUSTRIES **Course Code : 314003**

Programme Name/s : Chemical Engineering
Programme Code : CH
Semester : Fourth
Course Title : SAFETY IN CHEMICAL INDUSTRIES
Course Code : 314003

I. RATIONALE

Diploma chemical engineers have to deal with plant safety while working in chemical process industries. They should know the use of appropriate personal protective equipment, how to handle the different chemicals in a safer way. This course is designed to equip the students with necessary knowledge and skills for using of safe industrial practices, to identify and control the hazards in the chemical industry. This course provides the practical knowledge to control the fire and explosion hazards.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to use personal and other safety measures applicable 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 - Select the appropriate personal protective equipment (PPE) in the chemical industry.
- CO2 - Use the fire prevention and protection system in the chemical industry.
- CO3 - Control the given identified hazards in the chemical industry.
- CO4 - Apply different guidelines for safe handling of chemicals.
- CO5 - Enumerate major industrial disasters to avoid the repetition of similar accidents in the chemical industry.

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	
314003	SAFETY IN CHEMICAL INDUSTRIES	SCI	SEC	1	-	2	3	6	3	-	-	-	-	-	25	10	50@	20	25	10	100

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 Describe the need and limitations of PPE. TLO 1.2 Identify the appropriate Non Respiratory Equipment. TLO 1.3 Select the appropriate Respiratory Equipment. TLO 1.4 Describe the procedure for selection and usage of Respirators.	**Unit - I Personal Protective Equipment (PPE)** 1.1 Personal Protective Equipment : • Need • Limitation • Types • Indian Standards related to PPE 1.2 Non Respiratory Equipment and it's application: • Head & Hair Protection • Ear Protection • Face and Eye Protection • 1.3 Respiratory Equipment and its applications : Classification of Respiratory Hazards – • Oxygen Deficiency Protection • Gaseous Contaminants • Particulate Matter or Contaminants • Combination of Gaseous and Particulate Contaminants 1.4 Selection, Instruction and Training for use of Respirators	Demonstration Hands-on Presentations Video Demonstrations

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.
2	TLO 2.1 List out different Causes of Industrial Fire. TLO 2.2 Describe the classification of fire and extinguishers. TLO 2.3 Suggest the appropriate Fire Prevention and Protection systems. TLO 2.4 Describe the Fire emergency action drill. TLO 2.5 Explain the different types of explosion.	**Unit - II Fire, Explosion and it's prevention** 2.1 Fire Phenomenon: • Chemistry & Pyramid of Fire • F Common Cause of Industrial Fire 2.2 Classification of Fire and Extinguishers: • Class of Fire as per IS 15683:2018 – A, B, C, D, F, Class of Fire Extinguishers – • Water, Foam • Dry powder • Carbon dioxide • Wet chemical 2.3 Fire Prevention and Protection systems : • Preventive Measures • Fire Detection and Alarm Systems • Fire Suppression or Extinguishing Systems • Portable Fire Extinguishers • 2.4 Fixed Fire Installations : • Water spray, Foam • Automatic Fire Detection & Extinguishing System • Fire Emergency Action Plan & Drill 2.5 Explosion Phenomena: • Definition of Explosion, Types of Explosion – • Dust Explosion • Deflagration • Detonation • Concept of CVCE/UVCE/BLEVE	Demonstration Video Demonstrations Hands-on Presentations

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 different types of chemical hazards. TLO 3.2 Describe storage & handling hazards and its control. TLO 3.3 Explain process hazards and its control. TLO 3.4 Describe utility hazards and its control. TLO 3.5 Prepare Checklists for Routine Inspection of a Chemical factory.	**Unit - III Hazards and Controls in Chemical Industry** 3.1 Need of Safety in Chemical Industry with respect to hazards 3.2 Storage & Handling Hazards & it's Controls: • Storage Vessels & their Safety Aspects • Safe Storage & Handling of Flammable liquids, gases, solids & corrosive chemicals • Safe Storage & Handling of Chlorine, Ammonia and LPG 3.3 Process Hazards and Controls : • Exothermic Reactions • Pressure & Vacuum Reactions, Flammable / Explosive Reactions & Distillation • Toxic Reactions 3.4 Hazards & Controls: • Hazards related to Water, Air, Steam and it's control 3.5 Checklists for Routine Inspection of a Chemical factory & Work Permits for Hazardous work	Case Study Video Demonstrations Presentations Site/Industry Visit
4	TLO 4.1 Describe the different sections of Material Safety Data Sheet. TLO 4.2 List out precautionary measures for transportations of hazardous material. TLO 4.3 Prepare Emergency Information Panel for dangerous goods.	**Unit - IV Safe Handling of Chemicals** 4.1 Safe storage and handling of chemicals: • Safety in receiving, storage and handling of chemicals • Safety Data Sheet (SDS) as per IS-17889: 2022 • 4.2 Transportation of hazardous materials: • Safety precautions for transporting hazardous/ toxic/flammable/ explosive /radioactive substances by all modes 4.3 Transfer and Transportation of hazardous chemicals: • United Nations classification of dangerous goods • Class labels • TREM cards. • Hazards in loading and unloading of transfer of chemicals and safety measures	Site/Industry Visit Presentations Hands-on Video Demonstrations

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 Enumerate the pressure hazard and its consequences. TLO 5.2 Explain the Chemical hazard and its consequences. TLO 5.3 Describe the explosion hazard and its consequences. TLO 5.4 Explain the toxic hazard and its consequences.	**Unit - V Industrial Disasters (Case Studies)** 5.1 Flixborough disaster (1974): • Sequence of evidence • Identify hazards • Root cause and preventive measures 5.2 Seveso dioxin disaster (1976): • Sequence of evidence • Identify hazards • Root cause and preventive measures 5.3 Mexico LPG tank farm and explosion disaster (1984): • Sequence of evidence • Identify hazards • Root cause and preventive measures 5.4 Bhopal disaster (1984): • Sequence of evidence • Identify hazards • Root cause and preventive measures	Case Study Video Demonstrations Presentations

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 Identify the available hazards from the given scenario. LLO 1.2 Select appropriate Non-respiratory PPE accordingly. LLO 1.3 Apply appropriate steps to operate PPE.	1	* Demonstration of the Non-respiratory personal protective equipment for the given industrial hazard protection plan.	2	CO1
LLO 2.1 Identify the available hazards and select appropriate Respiratory PPE accordingly. LLO 2.2 Select appropriate respiratory PPE accordingly. LLO 2.3 Test the PPE and apply appropriate steps to operate it.	2	* Demonstration of the Respiratory personal protective equipment for the given industrial hazard protection plan.	2	CO1
LLO 3.1 Identify the type of fire. LLO 3.2 Select appropriate portable type of Fire extinguishers accordingly. LLO 3.3 Apply standard operating procedure to operate Fire Extinguishers.	3	* Conduction of a mock drill of portable type of Fire extinguishers which are available in your educational building.	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Identify the type of fire. LLO 4.2 Select appropriate fixed fire hydrant systems accordingly. LLO 4.3 Check the hydrant pressure and then operate it.	4	* Conduction of a mock drill of fixed fire hydrant systems which is available in your educational building.	2	CO2
LLO 5.1 Identify the type of fire. LLO 5.2 Select appropriate fixed fire hydrant systems accordingly. LLO 5.3 Check the hydrant pressure and then operate it.	5	* Determination of the fire load of chemical engineering laboratory.	2	CO2
LLO 6.1 Use the Indian or European MSDS. LLO 6.2 Sort out the important points from MSDS. LLO 6.3 Convert it into local language.	6	Preparation of a short material safety data sheet of chemicals used in your laboratory in English and local language.	2	CO3
LLO 7.1 Refer IS 14489 safety audit. LLO 7.2 Identify hazards and risk level of chemicals available in your chemical laboratory.	7	* Conduction of an Internal Audit of your chemical laboratory to identify hazards and risk level and make a report.	2	CO3
LLO 8.1 Refer the points from IS 17983. LLO 8.2 Prepare the work permit system of given hazardous work.	8	Preparation of work permit system for a given hazardous work as per IS 17893:2023.	2	CO3
LLO 9.1 Identify the hazards related to hazardous chemical. LLO 9.2 Prepare sequence for safe handling of Chlorine / Ammonia / LPG.	9	Preparation of a Standard Operating Procedure for safe handling of Chlorine / Ammonia / LPG.	2	CO3
LLO 10.1 Refer United Nation classification of dangerous goods. LLO 10.2 Draw the colourful symbols in a chart.	10	* Preparation of a chart of United Nation classification of dangerous goods including colourful symbols.	2	CO4
LLO 11.1 Refer Central Motor Vehicle Rule, 1989. LLO 11.2 Draw the Emergency Information Panel with scale of a given chemical.	11	* Preparation of a (Draw) Emergency Information Panel (with scale) of Chlorine / Sulfuric acid / Hydrogen with reference Central Motor Vehicle Rule, 1989.	2	CO4
LLO 12.1 Collect the information of available chemicals in your laboratory. LLO 12.2 Draw a colourful compatibility chart of the available chemicals.	12	Preparation of a compatibility chart of the chemicals which are available in your chemical laboratories.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Refer IS. 14489. LLO 13.2 Identify the hazards and risk of petrol pump and prepare a report.	13	* Conduction of a Safety Audit by visiting the nearest petrol pump and prepare a report as per IS 14489.	2	CO5
LLO 14.1 Refer chapter IV A of Factory Act 1948 LLO 14.2 Identify the permissible limits of toxic substances.	14	Preparation of a list of permissible limits of exposure of chemical and toxic substances of the industry you have visited with reference to Chapter IV A of Factory Act 1948.	2	CO5
LLO 15.1 Collect the detail information related to emergency instruments of education building. LLO 15.2 Describe the sequence of steps involved in mock drill.	15	* Conduction of emergency evacuation mock drill in your education building.	2	CO5
LLO 16.1 Refer Hierarchy of control in safety triangle. LLO 16.2 Explain the steps involved in the hierarchy of control.	16	Selection of the appropriate step from the Hierarchy of control triangle from the given example.	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)

Extra Activities

- 1. Prepare on site emergency plan for your educational building or educational campus giving details about its contents.

2. Prepare a report on Directorate of Industrial Safety and Health (DISH) website.
3. Prepare a accident report of any one industrial accident with reference to Maharashtra Factory Rule 1963 – Form 24.
4. Prepare a Sample of Safety committee of any one industry with reference to Rule No. 73J of Maharashtra Factory Rule 1963.
5. Prepare the details like eligibility, qualification, duties and responsibilities of Safety Officer with reference to Safety Officer Rule 1982 & Factory Act 1948.

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	Respiratory and Non-respiratory Personal Protective Equipment as per IS standards.	1,2
2	Public Address system	15
3	Portable Fire Extinguishers (CO2, Foam, Dry powder, clean extinguishing agent) as per IS standards.	3
4	Fire hydrant system	4

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	Personal Protective Equipment (PPE)	CO1	2	0	0	0	0
2	II	Fire, Explosion and it's prevention	CO2	3	0	0	0	0
3	III	Hazards and Controls in Chemical Industry	CO3	3	0	0	0	0
4	IV	Safe Handling of Chemicals	CO4	3	0	0	0	0
5	V	Industrial Disasters (Case Studies)	CO5	4	0	0	0	0
Grand Total				**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term Work 25 Marks **. Self Learning Assessment 25 Marks**

Summative Assessment (Assessment of Learning)

- **End of Term Examination (Internal) - 50@**

XI. SUGGESTED COS - POS MATRIX FORM

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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	3	-	-	2	1	1	3			
CO2	3	2	1	1	1	1	3			
CO3	3	2	1	-	2	1	2			
CO4	3	2	1	1	2	1	2			
CO5	3	3	1	1	2	1	3			

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	Dr. K. U. Mistry	Fundamentals of Industrial Safety and Health	Siddhant Prakashan, Ahmedabad, Gujrat
2	Crowl, Daniel A, Louvar, Joseph F.	Chemical Process Safety	Prentice Hall, NJ, USA, 2002, ISBN 0-13-018176-5
3	Bureau of Indian Standards	IS 14489: 1998	Government of India.
4	Bureau of Indian Standards	IS 17889: 2022	Government of India.
5	Bureau of Indian Standards	IS 17893:2023	Government of India.
6	Department of Environment, Forest and wildlife	The Manufacture, Storage, and Import of Hazardous Chemical Rules, 1989	Government of India.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.swayam2.ac.in/nou23_ge81/preview	Fire prevention and protection
2	https://onlinecourses.nptel.ac.in/noc20_mg43/preview	Functioning in safer way
3	https://archive.nptel.ac.in/courses/103/106/103106071/	Fire and Explosion
4	https://onlinecourses.nptel.ac.in/noc22_ch44/preview	General chemical safety measures
5	https://safetyculture.com/topics/ppe-safety/	Personal Protective Equipment (PPE)
6	https://www.indiatoday.in/india/video/bhopal-gas-tragedy-a-recap-2346629-2023-03-14	Case study of Major Disaster

Note :

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

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MSBTE Approval Dt. 21/11/2024 **Semester - 4, K Scheme**