

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021(COGC-2021) Semester-IV

Course Title: Safety and Pollution Control in Chemical Industry (Code: 4340504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	4 th Semester

1. RATIONALE:

In the race of becoming an economic powerhouse without compromising safety and environmental degradation is utmost priority for all stakeholders. Better Industrial safety and pollution control in chemical industries leads to improve in reputation, work culture and safe and smooth run of plant without breakdown which leads to economic growth. Chemical engineer plays an important role in industrial safety and pollution control. This course deals with basic concepts and methods for industrial safety and pollution control.

2. COMPETENCY:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use principles of safety & pollution control to operate plant safely, and control pollution within permissible limits in chemical industries.**

3. COURSE OUTCOMES(COs):

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

1. Understand basic concepts of Environment, Health & Safety.
2. Apply hazard control method in chemical industries.
3. Discuss hazard identification method & Risk assessment method.
4. Apply pollution control methods in chemical industries.

4. TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	150
3	0	2	4	30*	70	25	25	

(*):Out of 30marks under the theory CA,10 marks are for assessment of the micro-project to facilitate the integration of COs, and the remaining 20 marks are the average of 2 tests to be taken during the semester for assessing the attainment of the cognitive domain UOs required for the

attainment of the COs.

Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *CA* - Continuous Assessment; *ESE*-End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES:

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the PrOs marked '**' (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

Sr. No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Unit No.	Approx. Hrs Required
1	Prepare a report of "Learning From Incident" for a given Incident	I	2
2	Demonstrate handover of equipment(any one of heat exchanger/Pump/Vessel etc.) for maintenance by applying lock out tag out (LOTO)	II	2
3	Prepare Work permit for maintenance of any equipment (heat exchanger/Pump/Vessel etc.)	II	2
4	Demonstrate working of different fire extinguishers according to classes of fire	II	2
5	Apply HAZOP method for a given chemical plant or any job/task	III	2
6	Remove suspended Impurities from air using cyclone system	IV	2
7	Determine pH value of given sample of water.	V	2
8	Determine the chloride content in given sample.	V	2
9	Determine Total solid in given sample.	V	2
10	Determine dissolved oxygen of given sample.	V	2
11	Determine biological oxygen demand of given sample.	V	4
12	Determine chemical oxygen demand of given sample.	V	2
13	Measure dosage of alum for waste water treatment.	V	2
14	prepare chart of solid waste management method suitable for solid waste	VI	2
Total			30

Note

- I. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- II. The following are some **sample** 'Process' and '#Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Performance Indicators for the PrOs	Weightage in %
1	Handling of apparatus for precise measurements	10
2	Record observations correctly	20
3	Practice and adapt good and safe measuring techniques	10
4	Calculations, Interpretation of results and their conclusion.	20
5	Prepare report of practical in prescribed format	10
6	Solve assignment questions.	20
7	Viva-voce	10
Total		100

Sr. No.	Performance Indicators for the (Study)PrOs	Weightage in %
1	Understand importance of Practical	20
2	Prepare report of practical in prescribed format	30
3	Solve assignment questions.	30
4	Viva-voce	20
Total		100

6. MAJOR EQUIPMENT/INSTRUMENTS AND SOFTWARE REQUIRED:

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management to the institutes. This will ensure the conduction of practice in all institutions across the state in a proper way so that the desired skills are developed in students.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	pH meter: pH range-2.00 to +16.00, Resolution: 0.01, Accuracy: ± 0.02 , mV range: ± 1999 mV, Temperature range: -10 to +105°C	7
3	Incubator (BOD set up): Chamber volume:285.0 litre, range :+50C to 600C, controller accuracy:+/-0.50C set value of temp., PID Control: microprocessor based PID controller	11
4	Cyclone separator: 20" diameter cyclone dust collector,3" carbon steel straight wall and a 38" carbon steel cone tapering to an 8" x 8" discharge, 3" inlet and 3" exhaust. Splits in the middle for easy clean out	6
5	Weighing machine: Digital min. measurement 1 microgram	6, 8,9, 10, 11, 12, 13
6	Oven: Size: 24" x 24" x 24", Shelves: 2 Adjustable Wire mash type Heating Element: Ni-chrome wire, 1.5 kw, Temp. Controller: PID type, Front membrane keys LED Display, 250 °C, Max. Temp., Auto Tune facility, Power supply : Single phase, AC 230 volts from mains	9
7	Muffle furnace: Structure: Rectangular horizontal, Outer body: M.S powder coated, Complete with control gear bulb, Max. temperature Range: 900°C to1200°C, Digital display control indicator Muffle size: 9"*4"*4"	9

8	Fire Extinguisher: (1). DCP stored pressure type 6 kg, (2) Carbon dioxide Extinguisher 4.5 kg.	4
---	---	---

7. AFFECTIVE DOMAIN OUTCOMES:

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this competency.

- a) Work as a leader/a team member.
- b) Follow ethical practices
- c) Observe safety measures
- d) Good house keeping
- e) Time management
- f) Practice environmentally friendly methods and processes.

The ADOs are best developed through laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- i. 'Valuing Level' in 1st year
- ii. 'Organization Level' in 2nd year.
- iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY:

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the Cos and competency. If required, more such higher-level UOs could be included by the course teacher to focus on the attainment of Cos and competency.

Unit	Major Learning Outcomes	Topics and Sub-topics
	(in cognitive domain)	
Unit – I Introduction to Industrial Safety and pollution control	1a. Describe importance of safety in Industry	1.1 Importance of Industrial Safety and pollution control
	1b. Discuss Significant Industrial Disasters	1.2 Significant Industrial Disaster: Bhopal gas tragedy
	1c. Define Safety	1.3 terminologies: a. Safety b. Pollution c. Exposure d. Severity e. Probability f. Hazard g. Risk h. Accident i. Unsafe Act and Unsafe Condition j. Nearmiss k. Aspect and Impact

	1d. List out various Indian and International Safety, health and Environmental laws, and standards	1.4 Overview of Indian and International Safety, health and Environmental Standards and Laws Air and Water quality specifications by GPCB or CPCB)
Unit – II Hazards and Their Control	2a. Describe chemical Industrial hazards	2.1 Describe Chemical industrial Hazards a. Chemical hazard b. Electrical hazard c. Mechanical hazard d. Biological hazard e. Radiation hazard
	2b. Classify Chemical Hazard	2.2 Classification of Chemical hazard
	2c. List out various Occupational diseases and their causes	2.3 Occupational diseases and their causes
	2d. Explain Hazard control methods	2.4 Hazard control hierarchy
		a. Elimination b. Substitution c. Engineering Controls Ventilation and lighting, Enclosure, Isolation d. Administrative Controls Work permit system, Lock Out Tag Out (LOTO) Management, Drills and table top exercises, Good Housekeeping- 5S, Color codes and symbols for safety in chemical plants e. Personal Protective Equipments (PPEs)
	2e. Explain Fire Hazard and its control methods	2.5 Fire hazards & their causes 2.6 Fire Triangle and Fire Extinguishment method 2.7 Classes of fire and respective suitable firefighting equipment 2.8 Fire extinguisher operation: PASS
2f. Discuss MSDS	2.9 MSDS	
Unit – III Hazard Identification and Risk Assessment	3a. Explain Hazard Identification Methods	3.1 List out various Hazard Identification methods : 3.2 Explain Hazard Identification Method: Hazard Operability Study (HAZOP)
	3b. Explain Risk Assessment Methods	3.3 List out various Risk Assessment Methods 3.4 Explain Risk Assessment method: ETA and FTA

Unit – IV Air Pollution Control	4a. Define Air Pollution, Pollutants and its sources	4.1 Air Pollution Pollutants, and its sources
	4b. Describe Particulate control equipments	4.2 Particulate control equipments Gravity Settling Chamber, Cyclone separator, Fabric Filter, Wet Scrubber and Electrostatic Precipitator
	4c. Describe Thermal incineration	4.3 Thermal incineration, stack
	4d. Apply control methods for gaseous air pollution due to Sulfur dioxide emission	4.4 Methods for control of Sulfur dioxide emission a. Extraction of sulfur from fuels: Hydrodesulphurization of coal b. Desulphurization of flue gases by Wet processes (wet scrubbing methods)
	4e. Apply control methods for gaseous air pollution from Nitrogen Oxides.	4.5 Methods for control of Nitrogen Oxides a. Modification of operating condition b. Modification of design condition
Unit – V Water Pollution Control	5a. Define Water Pollution. 5b. List out different Water Pollutants and its sources	5.1 Water Pollution Pollutants, and its sources
	5c. Explain characteristics of water	5.2 characteristics of water DO, BOD, COD, VM, Suspended Matter (turbidity), TDS, pH
	5d. Describe removal of pollutants by applying Waste water treatment methods	5.3 Waste water treatment method a. Primary treatment i. Pretreatment ii. Sedimentation iii. Floatation b. Secondary treatment i. Aerobic process ii. Anaerobic process: Activated sludge process iii. trickling filter
	5e. Describe removal of pollutants by applying various treatment methods on suspended solids	5.4 Suspended solids treatment methods a. Micro straining b. Coagulation c. Filtration
	5f. List treatment methods for dissolved solids	5.5 Dissolved solids and treatment methods a. Ion exchange b. Reverse Osmosis

	5g. Explain oxidation and disinfection	5.6 Chemical oxidation/Disinfection
	5h. Explain Sludge processing	5.7 Thickening, Digestion, Conditioning, Dewatering, Oxidation and ultimate sludge removal
	5i. Describe Effluent treatment plant drawing schematic block diagram	5.8 Effluent treatment plant- ETP
Unit – IV Solid Waste Management	4a. Define solid waste 4b. Classify solid waste	4.1 solid waste classification
	4c. Explain methods of solid Waste Disposal	4.2 Methods of solid waste disposal a. Open Dumping b. Sanitary Land filling c. Incineration d. Compositing e. Reuse, recovery and recycling 4.3 Public Health aspects

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Industrial Safety and pollution control	4	2	5	0	7
II	hazards and Their Control	12	2	8	10	20
III	Hazard Identification and Risk Assessment	4	2	2	3	7
IV	Air Pollution Control	6	2	2	5	9
V	Water Pollution Control	12	2	8	10	20
VI	Solid Waste Management	4	2	2	3	7
	Total	42	12	27	31	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, the following are the suggested student-

related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Student should perform the following activities in group and prepare small reports of about 5 pages for each activity. They should also collect/record physical evidence such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

- a) Make a survey on Accident/incidents happened in your city with the help of newspaper/TV or any social media.
- b) Visit any public place and nearby industry, prepare a report on safety features incorporated at both place.
- c) Make a survey on awareness of people regarding firefighting and emergency response at your society/village. Conduct an awareness drive and again survey the same.
- d) Make a survey of air quality of your city with the help of internet.
- e) Visit nearby fire station and make a report of same.
- f) Make a report on Sewage water treatment plant located in your city.
- g) Make a survey of solid waste management in your city/village.
- h) Make a report on Environment Impact assessment of any project, Available on internet
- i) Prepare a report on Nature based solutions for climate change in India, Gujarat and your district/city/village. Efforts needed for their improvements. At last engage yourself for NBS and acknowledge same in the report with the help of photos.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/subtopics.
- b) Guide student(s) in undertaking micro-projects/activities.
- c) Different types of teaching methods i.e. video demonstration, activity based learning, case study, m-learning need to be employed by teachers to develop the outcomes.
- d) Some of the *topics/sub-topics* which is relatively simpler or descriptive is to be given to the students for *self-learning* but to be assessed using different assessment methods.
- e) Teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- f) Guide students to address issues on environment and sustainability with reference to using the knowledge of this course
- g) OERs, V-lab, and O-labs may be used to teach for the teaching of different concepts.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-project is group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application-based, internet-based, workshop-based,

laboratory-based, or field-based. Each micro-project should encompass two or more COs which are the integration of PrOs, UOs, and ADOs. Each student will have to maintain adapted work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The student sought to submit micro-project by the end of the semester (so that they develop industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly to the competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher.

- a) Prepare a Chart or Presentation of International and Indian safety health and environmental laws.
- b) Prepare a chart or presentation of various hazard symbols involved in chemical industries.
- c) Prepare a chart or presentation of color coding for piping and cylinders.
- d) Prepare a presentation of different Personal Protective Equipments.
- e) Prepare a chart of your institute layout having a safety features like escape route, firefighting equipment, and first aid kit etc. location mark.
- f) Develop a demonstration or working model of firefighting equipment.
- g) Prepare a Presentation of various Hazard identification and Risk Assessment methods.
- h) Prepare a presentation or demonstration or working model of any Particulate matter control equipments or gaseous pollution control methods.
- i) Prepare a case study report on any air pollution incident.
- j) Prepare a presentation or demonstration or working model of any water pollution control methods or solid waste management.
- k) Prepare a case study report on any water pollution incident.

13. SUGGESTED LEARNING RESOURCES:

Sr. No.	Title of Books	Author	Publication with place, year and ISBN
1	Manual of Chemical Technology, Chem tech-I	D.Venkateswarlu, K.R.Upadrashta, K.D. Chandrasekaran	Chemical Engineering Education Development Centre, IIT, Madras, 1975
2	Fundamentals of Industrial Safety & Health	Dr. K. U. Mistry	Siddharth Prakashan, Ahmadabad
3	Chemical Process Safety: Fundamentals with application	Daniel A. Crowl Joseph F. Lowar	3rd Edition, 2011, Prentice Hall, USA
4	Industrial Hygiene and chemical safety	M. H. Fulekar	I.K. International
5	Industrial Safety Management	N. K. Tarafdar, K. J. Tarafdar	Dhanpatrai and Co.Ltd., New-Delhi, 1st Edition, 2012

6	Industrial safety management	L. M. Deshmukh	Tata McGraw Hill, New Delhi, 2006
7	Industrial Safety, Health & Environment management	Sunil S. Rao, R.K. Jain	Khanna Publishers, New Delhi, 2006
8	Environmental Pollution control	C. S. Rao	New age international Pvt. Limited, 2nd edition
9	Pollution Control in Process Industries	S. P. Mahajan	Tata Mc GrawHill,
10	Text Book of Environmental Pollution and Control	Dr. Bhatia H. S.	Galgotia Publication, 1st edition, New Delhi
11	Environmental Engineering	G. N. Pandey, Carney G. C.	Tata Mc GrawHill, New Delhi
12	Industrial Safety and Environment	Anupama Prashar Pratibha Bansal	S.K.Kataria & Sons

14. SUGGESTED LEARNING WEBSITES

- <https://ndl.iitkgp.ac.in/>
- <https://www.vlab.co.in/>
- <https://nptel.ac.in/>
- <https://www.osha.gov/>
- <https://labour.gov.in/industrial-safety-health>
- <https://www.iso.org/popular-standards.html>
- <https://ndma.gov.in/>
- <https://www.csb.gov/videos/>
- <https://www.oisd.gov.in>
- <https://cpcb.nic.in/>
- <https://gpcb.gujarat.gov.in/>
- <https://www.accuweather.com/>
- <https://unfccc.int/>

15. PO-COMPETENCY-CO MAPPING

Semester IV	Safety and Pollution Control in Chemical Industry (4340504)						
	POs						
Competency & Course Outcomes	PO1 Basic & Discipline-specific knowledge	PO2 Problem Analysis	PO3 Design/development of solutions	PO4 Engineering Tools, Experimentation & Testing	PO5 Engineering practices for society, sustainability & environment	PO6 Project Management	PO7 Life-long learning

<u>Competency</u>	<ul style="list-style-type: none"> Use principles of safety & pollution control to operate plant safely, and control pollution within permissible limits in chemical industries. 						
CO1: Understand basic concepts of Environment, Health & Safety.	2	-	-	1	2	1	-
CO2: Apply hazard control method in chemical industries.	2	2	2	2	2	1	2
CO3: Discuss hazard identification method & Risk assessment method.	2	1	1	2	2	1	2
CO4: Apply pollution control methods in chemical industries.	2	2	2	2	3	1	2

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email ID
1	Ms. Khushbu N Chaudhary Lecturer in Chemical Engg.	G. P. Gandhinagar		khushbu.ch306@gmail.com
2	Mr. Savan S Prajapati Lecturer in Chemical Engg.	G. P. Rajkot		svnprajapati@gmail.com