

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

**COURSE TITLE: SAFETY AND HAZARD MANAGEMENT IN CHEMICAL
INDUSTRY**

(Code: 3340505)

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

1. RATIONALE

Chemical Industries are known as the most dangerous and hazardous industries since long. Varieties of conditions are present in chemical industries which may lead to different type of industrial accidents. Bhopal MIC leak accident is a world famous industrial accident which also happened in a chemical plant of Union Carbide Company in which thousands died and many got different diseases. Most of the industrial accidents are due to the human error or ignorance and responsible for the major losses to the industries and humanity. Use and handling of certain chemicals is also found to be dangerous as it may lead to health hazards. It is therefore essential for the technician to know about hazards, accidents, safe handling of chemicals, and operation of plant equipment and transportation of chemicals. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Handle chemicals and operate chemical plant safely**

3. COURSE OUTCOME

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Explain Indian and International Safety standards.
- Identify the causes of accident and explain various engineering control methods
- Explain storage, handling and transportation of hazardous materials.
- Classify fire extinguishing agents and methods
- Explain risk assessment methods.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to Industrial Safety and Hazards	1a. Describe importance of safety in Industry	1.1 Importance of Industrial Safety
	1b. Classify the hazards	1.2 Types of hazard (a) Chemical hazard (b) Thermal hazard (c) Electrical hazard (d) Mechanical hazard (e) Vibrational hazard (f) Biological hazard (g) Radioactive hazard
	1c. Explain Indian and International safety standards	1.3 Safety and health Standards 1.3.1 Indian Standards & codes for safety & health 1.3.2 International standard: OHSAS 18001
Unit – II Chemical hazards and Their Control	2a. Classify chemical hazards & their control 2b. Explain occupational diseases and poisoning 2c. Apply preventive measures of diseases	2.1 Classification of Chemical Hazards and their control 2.2 Chemicals as a cause of occupational diseases and poisoning 2.3 Prevention of diseases due to chemical effect
	2d. Describe safety aspects in plant layout 2e. Identify different colour codes for chemical plants	2.4 Safety aspects in plant layout, Ventilation and lighting 2.5 Color codes and symbols for safety in chemical plants (a) Classification of Color codes and symbols (b) Color codes for gas cylinders (c) Color codes for pipelines
	2f. Classify Personal Protective Devices 2g. List Personal Protective Devices in each	2.6 Personal Protective Devices (PPDs) (a) Non respiratory (b) Respiratory
Unit – III Safe Handling of Hazardous Chemicals	3a. Discuss characteristics of hazardous chemicals	3.1 Important characteristics and chemical reaction of 3.2 hazardous chemicals like (a) Chlorine (b) Nitric Acid (c) Ammonia (d) Carbon Monoxide (e) Caustic Soda (f) Phosphoric Acid

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		(g) Sulfuric Acid (h) HCl
	3b. Handle hazardous chemicals for Storage, Handling & Transportation	3.2 Storage, Handling & Transportation of hazardous chemicals
Unit – IV Fire Hazards and their Prevention	4a. Describe Fire hazards 4a1. List the causes of Fire hazards	4.1. Fire hazards & their causes
	4b. Explain fire triangle	4.2. Fire Triangle
	4c. Describe Classes of fire	4.3. Classes of fire
	4d. Describe fire extinguishers 4e. List types of extinguishers 4f. Describe Construction and working of fire extinguishers 4g. Describe Methods of their applications for fire extinguishers	4.4. Fire extinguishers 4.4.1 Classes of fire & types of extinguishers 4.4.2 Construction and working of fire extinguishers 4.4.3 Methods of their applications
Unit – V Hazard Identification and Risk Assessment	5a. Explain hazard identification methods	5.1 Hazard identification methods : a) Hazard Operability study (HAZOP), b) Hazard Analysis (HAZAN)
	5b. List risk assessment methods 5b1 Explain risk assessment methods	5.2 Risk Assessment methods: a) Failure mode and effect analysis (FMEA) b) Fault Tree analysis (FTA) c) Event Tree analysis (ETA)

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Industrial Safety and Hazards	06	4	4	2	10
II	Chemical hazards and Their Control	14	10	8	6	24
III	Safe Handling of Hazardous Chemicals	06	4	4	2	10
IV	Fire Hazards and their Prevention	06	4	4	2	10
V	Hazard Identification And Risk Assessment	10	8	6	2	16
Total		42	30	26	14	70

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only a general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr.No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Apprx. Hrs. Required
1	I	Prepare a chart of Indian safety standards	02
2	I	Identify different hazards in a given chemical plant	02
3	II	Identify different chemical hazards in a given chemical plant	02
4	II	Identify colour codes for pipelines	02
5	II	Identify colour codes for gas cylinders	02
6	II	Identify different safety symbols for chemical industry	02
7	II	Demonstrate Personal Protective Devices	02
8	III	Prepare a handouts of safe handling practices for hazardous chemicals	04

Sr.No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Apprx. Hrs. Required
1	I	Prepare a chart of Indian safety standards	02
2	I	Identify different hazards in a given chemical plant	02
9	IV	Demonstrate Fire triangle and classes of fire	02
10	IV	Demonstrate construction and working of different fire extinguishers	04
11	V	Apply HAZOP method using a case study	02
12	V	Apply Risk Assessment method for a chemical plant	02
Total Hrs			28

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities:

- Study of Fire extinguishers / Visit of a nearby fire station
- Study of personal protective equipments / visit to nearby industry
- Preparation of Material Safety Data Sheet of hazardous materials
- Visit to websites of reputed fire and safety equipment suppliers and study of features of their equipment/instruments/tools.

9. SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

- Show different video/Animated films about functioning of different safety equipment/fire prevention equipment
- Discuss case studies of major industrial disasters/accidents and cause for them.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

Sr. No.	Title of Books	Author	Publication
1	Manual of Chemical Technology, Chemtech-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. Crawl, Joshef F. Louvar	3 rd Edition, 2011, Prentice Hall, USA,
4	Industrial Safety Management	N. K. Tarafdar, K. J. Tarafdar	Dhanpatrai and Co.Ltd., New-Delhi, 1 st Edition, 2012
5	Industrial safety management	L M Deshmukh	Tata McGraw Hill, New Delhi, 2006
6	Industrial Safety, Health & Environment management	Sunil S. Rao, R.K. Jain	Khanna Publishers, New Delhi, 2006

B. List of Major Equipment/Materials

- i. Fire Extinguishers
 - CO₂ type, A, B, C type, Dry chemical powder type
 - Foam type- 9 litre, operation-inverted, ISS-933, Class B fire
- ii. Water type-CO₂ gas pressure, 9 litre, operation-upright, ISS-940, Class A fire
- iii. DCP type- 1,2,5 or 10 Kg, operation-upright, ISS-2171, Class B and C fire
- iv. Soda acid type-9 litre, operation-inverted or upright, ISS-934, Class B and C fire
- v. Respiratory & Non-respiratory personal protective devices:
- vi. Safety goggles, face screens, Industrial safety helmets, hairnets and fire fighters helmets, Earplugs, earmuffs, Gloves, Safety boots and shoes with protective toecaps and penetration-resistant, Apron, Chemical suit

C List of Software/Learning Websites

- i. <https://www.osha.gov>
- ii. <https://www.iso.org>
- iii. <https://www.bis.org.in>
- iv. <http://www.iffco.nic.in/applications/brihaspat.nsf>
- v. <http://sp.ehs.cornell.edu/lab-research-safety/laboratory-safety-manual/Pages/ch8.aspx>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. Mukesh B. Dhangar**, Lecturer in Chemical Engineering, Shri N. G. Patel Polytechnic, Isroli – Afwa.
- **Prof. Manish R. Nasit**, Lecturer in Chemical Engineering, Shri N. G. Patel Polytechnic, Isroli – Afwa
- **Prof. Nitin N. Hansalia**, Lecturer in Chemical Engineering, G. P. Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**, Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh**, Assistant Professor, Department of Applied Sciences