POLLUTION CONTROL IN CHEMICAL INDUSTRIES **Course Code : 314311**

Programme Name/s : **Chemical Engineering**
Programme Code : **CH**
Semester : **Fourth**
Course Title : **POLLUTION CONTROL IN CHEMICAL INDUSTRIES**
Course Code : **314311**

I. RATIONALE

Chemical Industry deals with the various chemical processes, which are responsible for major industrial pollution. This course of pollution control in chemical industry involves monitoring and controlling pollution from chemical process industry. This course is intended to familiarize students with the concepts of various traditional and modern pollution control methods along with identifying various pollutants, prevalent industrial laws and acts pertaining to safety, health and the environment through Indian context. This course would enable students to identify, assess, quantify, and manage the industrial pollution at any stage of operation.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: • Apply pollution control methods to mitigate different types of pollution in the 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 - Use relevant equipment for the control of air pollution in chemical process industry.
- CO2 - Select the appropriate treatment method required for treating chemical industrial wastewater.
- CO3 - Select appropriate disposal method for given chemical industrial solid waste.
- CO4 - Apply relevant treatment method for managing given hazardous waste.
- CO5 - Apply pollution control act to control pollution in 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	
314311	POLLUTION CONTROL IN CHEMICAL INDUSTRIES	PCCI	DSC	4	-	2	2	8	4	03	30	70	100	40	25	10	25#	10	25	10	175

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 Identify the chemical industries responsible for air pollution. TLO 1.2 Identify the type of air pollutants. TLO 1.3 Select relevant equipment for air pollution control in industry. TLO 1.4 Explain air pollution control method with reference to manufacturing industry.	**Unit - I Air Pollution and Control** 1.1 Sources and Types of air pollution in chemical industry. 1.2 Particulate pollutant and control– • Bag filter •Cyclone separator •Electrostatic precipitator •Wet scrubber 1.3 Gaseous pollutant and control – •Absorber •Catalytic converter •Thermal Incinerator •Stack Analysis. 1.4 Air pollution control in industries- •Sulphuric acid plant •Cement plant •Fertilizer Industry.	Video Demonstrations Presentations Lecture Using Chalk-Board

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 Identify the sources of wastewater in chemical industry. TLO 2.2 Explain characteristics of chemical industrial wastewater. TLO 2.3 Calculate BOD and COD of chemical industrial wastewater. TLO 2.4 Select the appropriate treatment method for given chemical industrial wastewater.	**Unit - II Water Pollution and Control** 2.1 Sources and characteristics of chemical industrial wastewater- •Turbidity •pH •Total suspended solids •Total solids •BOD and COD (Definition and Calculation of BOD and COD) 2.2 Waste Water Treatment: Primary methods: •Sedimentation •Forth flotation Secondary methods: •Activated sludge treatment •Trickling filter •Bioreactor Tertiary method: •Membrane separation- Microfiltration Ultrafiltration Nanofiltration (Only Concept) •Reverse Osmosis- Detail process of RO for wastewater treatment	Lecture Using Chalk-Board Video Demonstrations Presentations Site/Industry Visit
3	TLO 3.1 Identify the sources of solid waste. TLO 3.2 Explain steps of industrial solid waste management. TLO 3.3 Select disposal method for given solid waste. TLO 3.4 Explain the health consequences of poor industrial waste disposal.	**Unit - III Solid Waste Management** 3.1 Solid waste generation: Sources from industry 3.2 Steps of Industrial Solid Waste Management: •Collection •Transportation •Storage and disposal 3.3 Factors considered for the selection of disposal method 3.4 Disposal Methods- •Open burning •Sea dumping •Sanitary landfill •Composting •Incineration 3.5 Health Consequences of Poor Industrial Waste Disposal: •Carcinogenic and others	Video Demonstrations Presentations Lecture Using Chalk-Board Site/Industry Visit

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 sources of hazardous waste. TLO 4.2 Explain collection and storage process of hazardous waste. TLO 4.3 Select relevant treatment method for given hazardous waste. TLO 4.4 Explain the factors responsible for hazardous waste prevention and minimization. TLO 4.5 Explain the health consequences of poor industrial hazardous waste disposal.	**Unit - IV Hazardous Waste Management** 4.1 Hazardous Waste-Sources and Types. 4.2 Steps of Hazardous Waste Management: •Generation •Storage and collection •Transfer and transport •Processing and disposal 4.3 Treatment Methods for disposal: Physical and Chemical Treatment- •Filtration and separation •Chemical precipitation •Chemical oxidation and reduction (redox) •Solidification and stabilization •Evaporation •Ozonation Thermal Treatment-Pyrolysis Biological Treatment- •Enzymatic systems •Aerobic and anaerobic treatment 4.4 Pollution prevention and waste minimization- •Management support and employee participation •Training, Waste audits •Good operating practices •Material substitution practices •Technological modification practices •Recycling options •Surplus chemical waste exchange options 4.5 Health Consequences of Poor Industrial hazardous Waste Disposal: •Carcinogenic and others	Video Demonstrations Lecture Using Chalk-Board Presentations Site/Industry Visit

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 Explain role of central and state pollution control board. TLO 5.2 Describe the needs of air pollution control act. TLO 5.3 Apply water pollution control act in given industry. TLO 5.4 Explain salient features of hazardous waste management rule 2016.	**Unit - V Industrial Pollution control Act** 5.1 Central and State pollution control board: •Structure and role 5.2 Air pollution control act 1981: •Need and objective 5.3 Air quality act 2004 (Act No. 39 of 2004): •Need and objective 5.4 Water pollution control act 1974 (Act No. 6 of 1974): •Need and objective 5.5 The Water (Prevention and Control of Pollution) Amendment Bill, 2024: •Need and objective 5.6 Salient features of Hazardous waste management rule 2016	Video Demonstrations Case Study 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 Use high volume sampler to measure particulate pollutant. LLO 1.2 Explain the impact of particulate pollutant on the environment.	1	* Measurement of particulate pollutants using High Volume Sampler.	2	CO1
LLO 2.1 Use orsat apparatus to determine composition of flue gases LLO 2.2 Explain the impact of flue gases on the environment.	2	Determination of composition of flue gases using Orsat Apparatus.	2	CO1
LLO 3.1 Use pollution under control kit to measure pollutant concentration.	3	Measurement the concentration of pollutants from vehicle exhaust.	2	CO1
LLO 4.1 Use Kjeldahl apparatus to determine total nitrogen content in waste water. LLO 4.2 Explain the impact of nitrogen level in water.	4	*Determination of total nitrogen content in wastewater using kjeldahal apparatus.	2	CO2
LLO 5.1 Perform titration to determine chloride content in wastewater. LLO 5.2 Explain the impact of chloride level in water.	5	*Determination of chloride content in wastewater.	2	CO2
LLO 6.1 Use TDS meter to determine total dissolved solids in wastewater. LLO 6.2 Explain the impact of TDS level in water.	6	*Determination of total dissolved solids in wastewater.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Use DO meter to determine dissolved oxygen in wastewater. LLO 7.2 Explain the importance of dissolved oxygen in water.	7	Determination of dissolved oxygen in wastewater.	2	CO2
LLO 8.1 Use COD apparatus to determine Chemical Oxygen Demand of the given effluent sample. LLO 8.2 Explain the concept of Chemical Oxygen Demand	8	Determination of Chemical Oxygen Demand of the given effluent sample.	2	CO2
LLO 9.1 Use BOD apparatus to determine Biological Oxygen Demand of the given effluent sample. LLO 9.2 Explain the concept of Biological Oxygen Demand	9	*Determination of Biological Oxygen Demand of the given effluent sample.	2	CO2
LLO 10.1 Use turbidity meter to measure turbidity of given wastewater sample.	10	*Measurement the turbidity of given wastewater sample.	2	CO2
LLO 11.1 Use jar test method to measure the appropriate dosage of alum for waste water. LLO 11.2 Explain the concept of coagulation and flocculation in wastewater.	11	Measurement the appropriate dosage of alum in wastewater using jar test method.	2	CO2
LLO 12.1 Perform titration to determine the neutralization point of waste water.	12	*Determination of neutralization point for charcoal treatment of acidic wastewater.	2	CO2
LLO 13.1 Calculate density of given solid waste by using weighing balance.	13	* Determination of density of solid waste.	2	CO3
LLO 14.1 Use specific gravity bottle to determine density of hazardous waste.	14	* Determination of density of hazardous waste.	2	CO4
LLO 15.1 Use potable arsenic kit to determine arsenic content in water. LLO 15.2 Explain the effect of arsenic on the human body.	15	Determination of Arsenic content in water.	2	CO4
LLO 16.1 Use CPCB online monitoring system for analysis of air quality index of various cities.	16	*Measurement of air quality index of five different areas of your city on the basis of national ambient air quality standards.	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)

Micro project

- Collect data and prepare report of various equipment used to control the air pollution in chemical industry.
- Prepare model of sedimentation tank by using waste material.
- Prepare list of industries which are using solid waste as a raw material and write report on manufacturing process.
- Prepare animation video on working of effluent treatment plant.
- Visit the industries and prepare report on treatment method used for disposal of hazardous waste.
- Prepare report on love canal disaster.

Assignment

- Prepare visit report on possible air pollutants emitted from nearby industry.
- Prepare Power Point presentation on Water (Prevention and Control of Pollution) Amendment Bill, 2024.
- Prepare report on disposal method for biomedical waste.
- Visit to nearby industry and prepare report on production of energy from solid waste material.
- Visit the municipality water treatment plant and prepare a report on Physical, Chemical and Biological treatment processes.

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	High Volume Sampler. Flow Rate: 0.8 to 1.8 m3/min, Particle Size: Down to 1.6 micron depending upon Filter used, Blower: Continues duty blower with brushless Motor, Recommended filter: GF/A (8” X 10”) for common use, EPM 2000 for Special Research or equivalent, Time Record: 0 to 99999.99 hrs. Time totalizer records the running time in hours, Timer: 24 Hrs Programmable timer, number of required intervals can be programmed, Power requirement: 220Volts, Single phase AC.	1
2	Turbidity Meter. Range: 0 - 10,000 NTU Principle of Operation: Nephelometric Ratio (Color Correction): Full Time ON or OFF, Accuracy: ± 2% of reading plus 0.01 NTU (0 to 1000 NTU), Resolution: 0.0001 NTU on Lowest Range, Response Time: less than 6 seconds, Sample Size: 30 ml, Light Source: Quick connect Infrared, Operating Temperature: 0° - 50°C, Air Purge: Connection for external dry air supply, Outputs: RS-232 Serial Port	10

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
3	Jar test Apparatus. No. of Jar (Stirrer options): - 6 Speed range: - 2 to 250 RPM (Made available in variable speed control) Timer: -Digital timer supports – 0 to 99 minutes Controls Keypad: - Touch-sensitive Digital Display: -LED, digital rpm indicator support Power: - 220 v ac supply, 50 Hz, 100 W Temperature: - 35 oC Accuracy: ± 2 RPM Size: - Standard and Customized Body: -Powder-coated body finish	11
4	Orsat Apparatus. Three absorption pipettes of two compartment type, 100 ml Gas Burette with outer jacket, Three Test Manifold with stopcocks, Aspirator bottle, for the analysis of CO, O2, CO2 particularly in fuel and furnace gases, Wooden cabinet with sliding doors.	2
5	PUC Kit. Leak Test: No, Technology Used to check the parameters: Electrochemical, Optional Sensors: Temperature, Number of Impringer: 1, Parameters to check - CO,CO2,HC,O2, Nox, Sox., Standard Accessories: Sampling probe, Buttons: Soft Touch Keys, Display Type: LCD, Calibration tests Certificate: Yes.	3
6	Kjeldahal Apparatus. Heating mantle: - 6 Flask Capacity: -500 ml Structure: - Power coated MS Cabinet Temperature: - Ambient + 10 oC to 350 oC Heating element: - Nichrome heating element, Temperature Controller: - Energy regulator, Heating Surface: - Fiber glass net, Power Supply: - 220 V, 50 Hz, Optional: PID Controller.	4
7	DO meter. Range: 0-500%. Temperature: -5 oC to 55 oC. Resolution: 0.1 oC, Accuracy: ± 0.3 oC	7
8	COD Apparatus. Temperature Range: Above ambient to 180° C or higher, Temperature Resolution: 0.1° C, Display: Digital 12mm Red LED, Control: Digital Electronic Temperature Controller, Heater Rating: 750 Watts, Sensor: PT?100, Timer: Selectable 15, 30, 45, 60, 90 or 120 minutes with alarm, Hole Size: 38mm Diameter x 76mm Depth, Glass Tube: 36mm diameter, 06 no (2 x 3 rows), Sample Volume: 20 ml Each, Overall size: 21 x 12 x 11", Net weight w/o packing: 21 kilograms	8
9	BOD Apparatus. Temperature Range-5°C to 60°C, Temperature Accuracy- ± 0.5°C, Temperature Uniformity- ± 1°C, Temperature sensor PT-100, Temperature Controller- PID temperature controller LED display of SV & PV, Construction Double walled with PUF Insulation, Inner Construction-Stainless Steel 304 grade, Exterior Construction Powder Coated GI sheet, Exterior Door Solid door with lock & key, Inner door-Glass door to view samples, Trays-Wire mesh cable trays (removable), Interior illumination LED Light, Heating Element-U-shaped SS tubular heaters, Refrigeration System CFC Free Compressor, Air Circulation Motorized Blower / Axial fan, Safety-Temperature High / Low alarm, Power supply-220 Volts 50 Hz	9
10	Weighing balance- Accuracy 0.1 mg to 500 gm	All
11	Glassware: Burette, Pipette, Conical Flask, Beaker, Measuring Cylinder, Specific gravity bottle etc.	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	Air Pollution and Control	CO1	12	4	6	4	14
2	II	Water Pollution and Control	CO2	14	2	8	6	16

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Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	Solid Waste Management	CO3	10	4	4	4	12
4	IV	Hazardous Waste Management	CO4	14	2	8	6	16
5	V	Industrial Pollution control Act	CO5	10	4	4	4	12
Grand Total				**60**	**16**	**30**	**24**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two Class Test of 30 Marks.
- Each practical will be assessed considering: 60 % weightage to process, 40 % weightage to product.

Summative Assessment (Assessment of Learning)

- End of Term Theory Examination.
- End of Term Practical Examination

XI. SUGGESTED COS - POS MATRIX FORM

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	2	1	2	3	1	2			
CO2	2	2	1	2	3	1	2			
CO3	2	2	1	2	3	1	2			
CO4	2	2	1	2	3	1	2			
CO5	1	-	-	-	3	-	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	Rao, C. S.	Environmental Pollution Control and Engineering	New Age International Publication, New Delhi, 2015. ISBN: 81-224-1835
2	S.P. Mahajan	Pollution Control in Process Industries	Tata McGraw Hill Publishing Company, 1985, ISBN: 0074517724, 9780074517727.
3	Soli J Arceivala, Dr. Shyam R. Asolekar	Waste water treatment for pollution control and reuse.	McGraw Hill Education (India) Private Limited, ISBN: 9780070620995
4	A D Patwardhan	Industrial Solid Waste	Teri Press, New Delhi, 2013, ISBN:9788179935026

Sr.No	Author	Title	Publisher with ISBN Number
5	Michael D. Lagrega, Phillip L. Buckingham	Hazardous Waste Management.	McGraw Hill Education (India) Private Limited, ISBN: 978-0070195523
6	Central Pollution Control Board.	Pollution Control Acts, Rules & Notifications Issued Thereunder	Central Pollution Control Board, ISBN: 978-2021152036.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://ceerapub.nls.ac.in/wp-content/plugins/pdfjs-viewer-shortcode/pdfjs/web/viewer.php?file=/wp-content/uploads/2020/01/Handbook-on-Waste-Management-book.pdf&dButton=false&pButton=false&oButton=false&sButton=true	E-Book-Handbook on Chemicals and Hazardous Waste Management and Handling in India
2	https://www.nptelvideos.com/video.php?id=1936&c=11	Sources of air pollution
3	https://archive.nptel.ac.in/courses/123/105/123105001/	Fundamentals of Environmental pollution and control
4	https://archive.nptel.ac.in/courses/105/106/105106056/	Physiochemical Treatment of solid and hazardous waste
5	https://cpcb.gov.in	Analysis of air quality index.

Note :

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