Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Fifth**

Course Title : **Environmental Technology**

Course Code : **22511**

1. RATIONALE

Chemical technologists have to deal with Environmental Pollution and control in chemical process industries. They have to apply environmental science, environmental monitoring and electronic devices used for monitoring and analysis of environmental pollution generated by various sources. Information about the environmental Pollution and control methods may used to control air and water pollution. They have to undertake waste water treatment, solid waste management and environmental audit with ISO 14000. This course is designed to equip the students with necessary knowledge and skills related to the environmental pollution and control for effectively performing the job role.

2. COMPETENCY

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

- **Conserve environment using various pollution control measures.**

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:

a. Identify the source of global warming and ozone depletion.
b. Use relevant equipment for the control of air pollution in chemical process industry.
c. Test the different properties of waste water.
d. Use land fill and incineration methods for treatment of industrial solid waste.
e. Apply ISO14000 environmental protection norms for chemical industry.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment 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, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

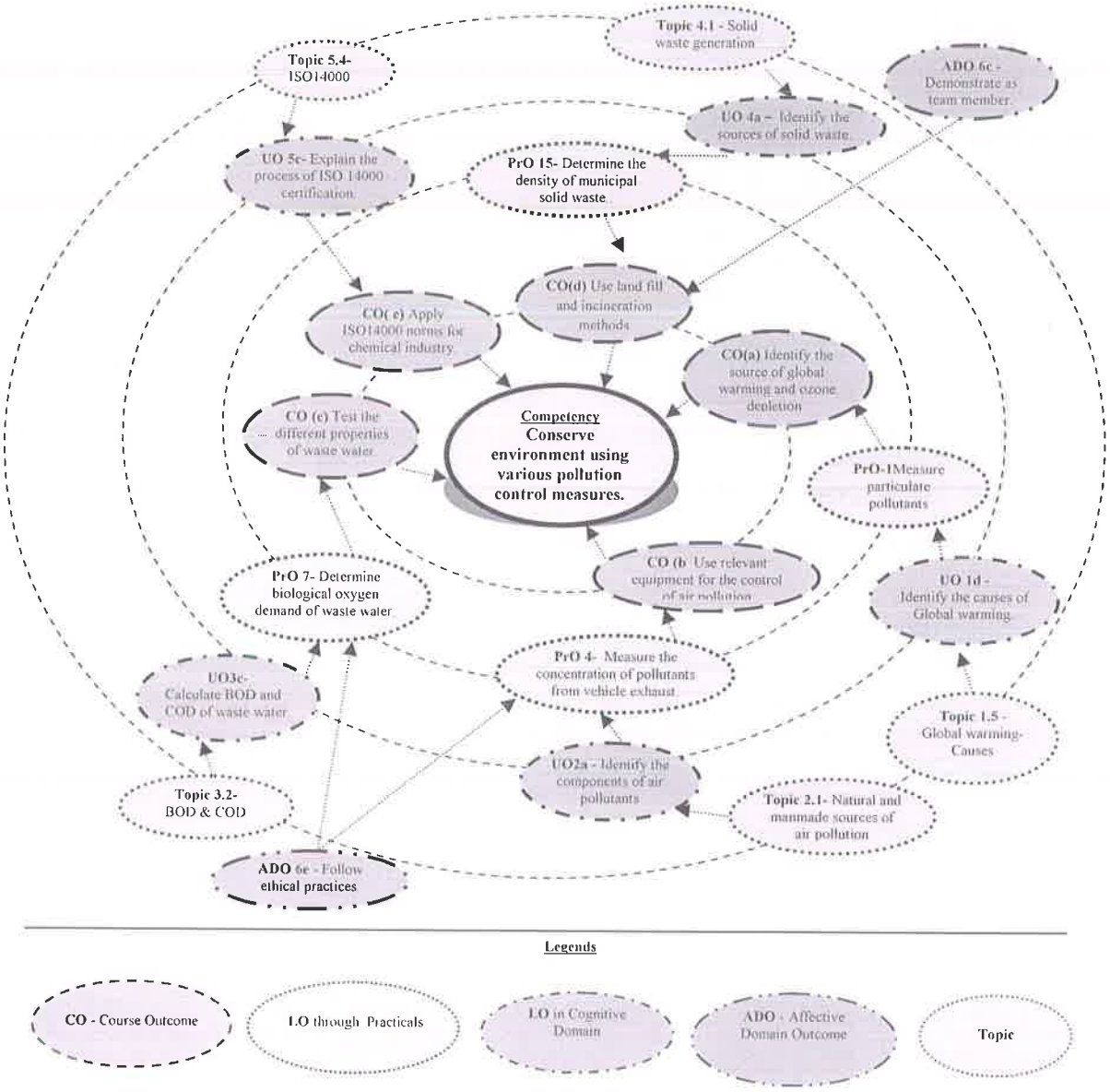

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals/exercises/tutorials in this section are psychomotor domain LOs (i.e.sub-components of the COs) are to be developed and assessed in the student to lead to the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Measure particulate pollutants using High Volume Sampler.	I	02
2	Determine the composition of flue gases using Orsat apparatus	I	02
3	Determine the total nitrogen content in waste water using Kjeldahl apparatus	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Measure the concentration of pollutants from vehicle exhaust.	II	02
5	Determine the chloride content in waste water.	III	02
6	Determine the total solids in waste water.	III	02
7	Determine the dissolved oxygen in waste water.	III	02
8	Determine biological oxygen demand of waste water.	III	02
9	Determine the Chemical oxygen demand of waste water.	III	02
10	Determine the turbidity of waste water using turbidity meter.	III	02
11	Measure the appropriate dosage of alum for raw water using jar test method.	III	02
12	Determine the Sulphate content in waste water	III	02
13	Determine the neutralization point for charcoal treatment of acidic waste water.	III	02
14	Determine the strength of alkaline material in waste water using acid base titration.	III	02
15	Determine the density of municipal solid waste.	IV	02
16	Determine the density of hazardous waste.	IV	02
	Total		**32**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Work as a leader/a team member.
d. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs

according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

S. No.	Equipment Name with Broad Specifications	PrO. S.No.
1	High volume sampler Motor: 0.6 HP, Power: 6.25amp, 750W, Flow set point: 40SFCM, Mass flow control accuracy: +/-2.5% deviation(24 Hrs), Power source: 110 V 1 Phase, 60 HZ ,Weight: 61kg , For laboratory purpose	01
2	Orsat Apparatus: Three absorption pipette, Two compartment type, 100ml gas burette with outer jacket, manifold with stopcocks and aspirator bottle for the analysis of CO, O_2, CO_2 particularly in fuel and furnace gas. Wooden cabinet with sliding doors.	02
3	B.O.D. incubator: Chamber Volume: 285lit, Cu. Ft-10, Internal size: CMS-57X57 X 88, External size: CMS 70X85X166, Shelves-2: Range :+5°C to 60°C	07
4	C.O.D. digester: Multifunction dry bath fitting, Temperature control from ambient +5°C to 150°C with +1°C accuracy	08
5	Zeldal Apparatus	03
6	DO meter : Temperature range: -5°C to 55°C, Resolution: 0.1°C , Accuracy: +/-0.3°C, Range: 0 to 500%	09
7	PUC Kit Component — Range — Resolution CO — 0-15% — 0.01% CO2 — 0-19.9% — 0.1% HC — 0-20000ppm — 1 ppm O2 — 0-25% — 0.01% NOx — 0-5000ppm — 1 ppm Power Supply — 12V DC, 230VAC, Single Phase, 50-60Hz Power: 25W	04
8	Turbidity Meter: Range: 0-10000NTU, Principle: Nephelometric, Ratio: Full time ON or OFF, Accuracy +/- 2% of reading + 0.01NTU, Resolution: 0.0001NTU Response time <6sec, sample size: 30ml, light source :IR, temperature: 0°C to 50°C, Air purge: External dryer supply	11
9	Weighing Balance: Accuracy 0.1mg to 500gm	All Practicals
10	Stop Watch	
11	Desicator	07
12	Oven: Max Temperature 1000 °C, minimum Temperature +30 °C, Volume 28 to 128 Litres.	06
13	Reflux Condenser: 500ml flask with condenser assembly	08
14	Filter Paper	06
15	Heater	06, 07
16	Galssware: Burrete, Pippette, Conical Flask, Beaker, Measuring Cylinder, Specific gravity Bottle etc.	All experiment

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Ecosystem	1a. Identify the components of Biotic and Abiotic system. 1b. Differentiate the Aquatic and Terrestrial ecosystem 1c. Identify the relevant chemical cycles in given Ecosystem 1d. Identify the causes of Global warming.	1.1 Structure of Ecosystem, Biotic and Abiotic components 1.2 Food Chain and Food web 1.3 Aquatic(Lentic and Lotic) and Terrestrial ecosystem 1.4 Carbon, Nitrogen, Sulphur, Phosphorus Cycle. 1.5 Global warming-Causes, effects, process, Green House Effect, Ozone depletion
Unit– II Air Pollution and Control	2a. Identify the components of air pollutants 2b. Apply relevant separator for air pollution control in chemical process industry. 2c. Apply the method for stack analysis for given system. 2d. Identify the effects of air pollution on human health.	2.1 Natural and manmade sources of air pollution, 2.2 Air Pollutants: Types, measurement of particulate pollutants, 2.3 Particulate Pollution control: Bag filter, Cyclone separator, Electrostatic Precipitator, Wet Scrubber 2.4 Gaseous Pollution Control: Absorber, Catalytic Converter, Thermal Incinerator(Flare), Stack Analysis 2.5 Air pollution and control in industries: Sulfuric Acid Plant, Nitric Acid Plant, Cement Plant 2.6 Effects of air pollution on human health
Unit– III Water Pollution And Control	3a. Identify sources of water pollution 3b. Identify the pollutants in waste water 3c. Calculate BOD and COD of waste water 3d. Apply the Bioreactor for given chemical system. 3e. Identify relevant method for treatment of given waste water.	3.1 Sources of water pollution, Types of water pollutants, Characteristics of water pollutants: Turbidity, pH, total suspended solids, total solids 3.2 BOD and COD: Definition, calculation 3.3 Waste Water Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, Application of RO in waste water treatment
Unit-IV Solid Waste Managemen t	4a. Identify the sources of solid waste. 4b. Differentiate the various types of solid waste. 4c. Apply the principle of 3R	4.1 Solid waste generation 4.2 Sources and characteristics of : Municipal solid waste, Hazardous waste, Biomedical waste. 4.3 Collection and disposal : MSW(3R

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	4d. Apply the scientific method of sanitary landfill	principles, energy recovery, sanitary landfill), Hazardous waste, Biomedical waste 4.4 Love canal episode
Unit-V ISO 14000 and Environmental Management	5a. Apply the air and water pollution control act in given industry. 5b. Identify the role of different pollution control boards for given application. 5c. Explain the process of ISO 14000 certification. 5d. Apply various pollution control act for chemical industry.	5.1 Air quality act2004, air pollution control act 1981 and water pollution and control act1996. 5.2 Structure and role of Central and state pollution control board 5.3 Environmental management in industry 5.4 ISO14000: Implementation in industries, Benefits.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Ecosystem	04	04	04	04	12
II	Air Pollution and Control	06	06	06	06	18
III	Water Pollution and control	04	04	08	06	18
IV	Solid Waste Management	04	04	04	06	14
V	ISO14000and Environmental Management	02	02	04	02	08
Total		**48**	**20**	**26**	**24**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

a) List any five types of ecosystems near the institute.
b) Identify the possible air pollutants from your MIDC area/vehicle
c) Preparation of artificial waste water and suggest treatment method.
d) Visit to nearest water purification/Effluent treatment plant.
e) Prepare the chart of solid waste management showing effects on environment.

11. 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) Use animations to demonstrate the various environmental pollution and control processes.
b) Use videos available on the internet to teach some topics.

c) Guide student(s) in undertaking micro-projects.
d) Give Mini projects to students.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. **Dust Fall Jar:** Construction and analysis of pollution trend in the selected area.
b. **Collection of Data from Internet :** Respiratory suspended particulate matter (RSPM) in various metro cities in India
c. **Fabrication:** Fabricate Sedimentation Tank in the laboratory.
d. **Effluent and Influent:** Collect information on Effluent and Influent composition of petrochemical industry.
e. **Sample collection:** Collect the sample from municipal solid waste.
f. **Identify Industry:** Identify and list the industries using the solid waste as raw material.
g. **ISO Implementation:** List and categorize the industries certified with ISO 14000 in India.
h. **Environmental Audit:** Prepare the sample document for environmental Audit of any Organization.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Waste Water Treatment for Pollution Control and Reuse	Arceivala, Soli Asolekar, Shyam	Mc-Graw Hill Education India. New Delhi, 2015, ISBN:978-07-062099-5
2	Environmental Engineering Science	Nazaroff, William Cohen, Lisa	Wiley, Newyork, 2000, ISBN 10: 0471144940
3	Environmental Pollution Control and Engineering	Rao, C. S.	New Age International Publication, New Delhi, 2015,, ISBN: 81-224-1835-X
4	Air Pollution	Rao, M. N. Rao, H.V.N.	Mc-Graw Hill Education India., New delhi, 1988, ISBN: 0-07-451871-8
5	Waste Water Engineering	Metcalf and Eddy	Mc-Graw Hill, 2013, ISBN: 077441206
6	Industrial Solid Waste	Patvardhan, A.D.	Teri Press, New Delhi, 2013, ISBN:978-81-7993-502-6

14. SOFTWARE/LEARNING WEBSITES

a) www.eco-prayer.org
b) www.teriin.org
c) www.cpcp.nic.in
d) www.cpcp.gov.in
e) www.indiaenvironmentportal.org.in
f) www.whatis.techtarget.com
g) www.sustainabledevelopment.un.org
h) www.conserve-energy-future.com