Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Fourth**

Course Title : **Technology of Organic Chemicals**

Course Code : **22410**

1. RATIONALE

Diploma chemical engineers have to work as plant operator. During their course of work they have to deal with various aspects of manufacturing technology. It is essential for them to giving maximum output with minimum cost and pollution .This subject will provide information towards raw materials, process and industrial application for manufacturing of organic chemicals like Alcohol, oil, soap, polymer, phenols, pulp and paper these technology will provide necessary skill to perform the job role.

2. COMPETENCY

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

- **Apply the concept of organic chemistry in chemical engineering applications.**

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. Use fermentation process for manufacturing of alcoholand its products.
b. Prepare the soap and detergent using relevant oils.
c. Use hiding power principle for manufacturing of paint varnishes and lacquers .
d. Use polymerization process for preparation of various polymers.
e. Prepare phenol using per oxidation process.
f. Prepare pulp and paper using sulphate and suphite process.

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
4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): 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.

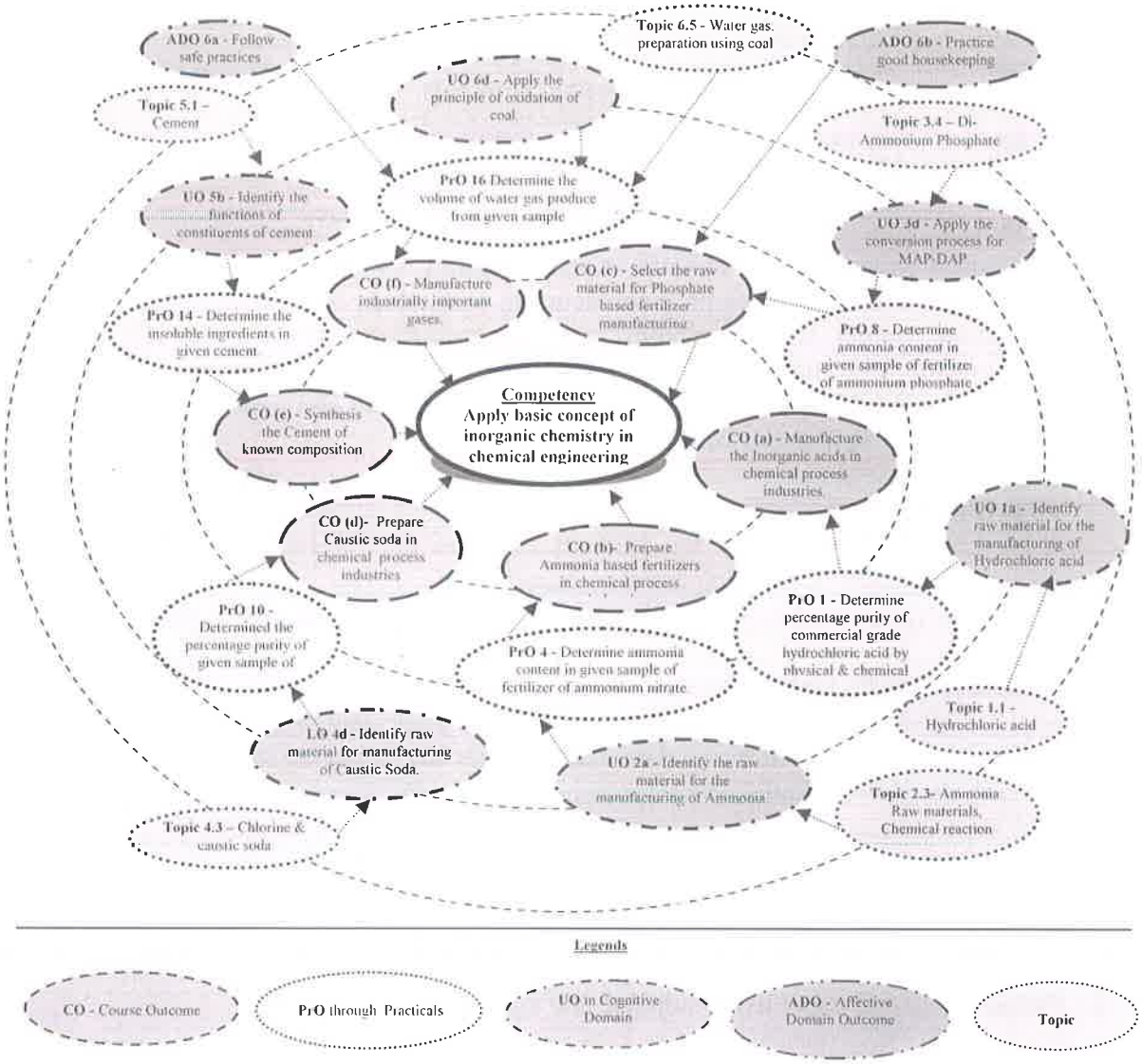

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Estimate the strength of glacial acetic acid by titration.	I	04
2	Prepare ethyl acetate from ethanol and acetic acid.	I	04
3	Determine viscosity of groundnut oil using Redwood viscometer.	II	04
4	Determine viscosity of castor oil using Redwood viscometer.	II	04
5	Determine viscosity of soyabean oil using Redwood viscometer.	II	04
6	Determine iodine value of oil by titration method.	II	04
7	Determine saponification value of lubricating oil by KOH titration method.	II	04

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Estimate the strength of glacial acetic acid by titration.	I	04
8	Determine Acid value of lubricating oil by KOH titration method.	II	04
9	Prepare soap by batch saponification process.	II	04
10	Determined the moisture content of soap.	II	04
11	Determine hiding power of given sample paint.	III	04
12	Determine the percentage of thinner in given sample of oil paint.	III	04
13	Prepare Phenol formaldehyde resin on laboratory scale.	IV	04
14	Determine Acid Value of given sample of polymer.	IV	04
15	Determine Acid Value of given sample of Phenol	V	04
16	Perform Decolourization of paper by bleaching.	VI	04
	Total		**64**

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 %
2	Preparation of experimental set up	20
3	Setting and operation	20
4	Safety measures	10
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	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. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. 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 and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

S. No.	Equipment Name with Broad Specifications	PrO S. No.
1	Beakers (100ml to 500ml)	All Expt.
2	Burette with stand, 50 ml	All Expt.
3	Thermometer	10,11
4	Redwood Viscometer	03,04,05,
5	Conical flask (100 to250ml.)	All Expt.
6	pipette (10 to 25ml)	All Expt.
7	Measuring cylinder (10 to 50ml)	All.Expt.
8	Weighing balance	All Expt.
9	Ceramic crucible	12,10.09
10	Laboratory oven	10
11	Bottles (250ml)	All Expt.
12	Test Tube (20ml)	All Expt.
13	Iodine flask (250ml)	06

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Alcohol	1a. Identify raw material for manufacturing of the given alcohol. 1b. Describe with sketches the process flow diagram for the given manufacturing of Acetic acid. 1c. Identify the components of chemical reaction for the given manufacturing process with justification. 1d. Describe with sketches the use of esterification process in the given acetate manufacturing.	1.1 Alcohol by molasses: Raw materials, chemical reaction, manufacturing process, Process flow diagram, Industrial applications, , Manufacturing industries. 1.2 Alcohol by corn: Raw materials, chemical reaction, manufacturing process, Process flow diagram, Industrial applications, , Manufacturing industries. 1.3 Acetaldehyde: Raw materials, chemical reaction, manufacturing process, process flow diagram, applications. 1.4 Ethyl acetate and Butanol: Raw materials, chemical reaction, manufacturing process, Process block diagram, industrial applications.
Unit– II Oil, Soap and Detergents	2a. Identify the raw material for manufacturing of the given oil with justification. 2b. Describe with sketches the process flow diagram of manufacturing for the given	2.1 Oil: Raw materials, manufacturing process, process flow diagram Hydrogenation of oil, applications, Economics, manufacturing industries. 2.2 Soap: Raw materials, Chemical reaction, manufacturing process,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	soap. 2c. Identify the raw material for the given soap with justification. 2d. Identify the components of chemical reaction for the given detergent with justification.	process flow diagram, manufacturing industries 2.3 Detergents - Raw materials, chemical reaction, manufacturing process by sulfated fatty alcohol,
Unit– III Paint, Varnishes and Lacquers	3a. Describe with sketches the applications of the given paint. 3b. Select relevant pigment for the given paint with justification. 3c. Choose use of oil and spirit varnishes with justification. 3d. Describe with sketches the application of the given varnish. 3e. Describe with sketches the application of lacquers in the given industry.	3.1 Paint: Raw materials, manufacturing process, process block diagram, industrial applications, manufacturing industries 3.2 Varnishes: Raw materials, manufacturing process, industrial applications, manufacturing industries 3.3 Lacquers: Raw materials, manufacturing process, industrial applications, and manufacturing industries
Unit-IV Polymers	4a. Describe with sketches the process of addition polymerization for the given polymer. 4b. Describe with sketches the chemical reaction for manufacturing of the given polyester. 4c. Explain the concept of cleavage formation in manufacturing of the given polyester. 4d. Describe with sketches the industrial application of the given polycarbonate.	4.1 Polyethylene: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications, manufacturing industries. 4.2 Polyvinyl chloride: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications, manufacturing industries. 4.3 Polyester: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications, manufacturing industries 4.4 Polycarbonate: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications, manufacturing industries
Unit –V Phenol	5a. Explain the concept of cleavage in the given process. 5b. Explain the concept of alkylation in the given formation. 5c. Describe the process of oxidation in the given preparation of phenol. 5d. Identify ingredients for the given manufacturing process of	5.1 Phenol by Cumene: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications, manufacturing industries 5.2 Phenol by Toluene- Raw materials, chemical reaction, process flow diagram, manufacturing process. 5.3 Phenol by Rasching process- Raw materials, chemical reaction, process

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Phenol.	flow diagram, manufacturing process.
Unit -VI Pulp and Paper	6a. Identify the raw materials for the given pulp with justification. 6b. Describe with sketches the principle of digester for the given making process of pulp. 6c. Explain with sketches the concept of web formation for the given making process of paper. 6d. Identify the raw material for the given paper with justification.	6.1 Pulp: Raw materials, process flow diagram, manufacturing process (sulphate and sulphite). 6.2 Paper: Raw materials, process flow diagram, manufacturing process, and manufacturing industries

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

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	Alcohol	12	04	06	04	14
II	Oil,Soap and Detergent	12	02	04	04	10
III	Paint,Varnishes and Lacquers	08	00	04	04	08
IV	Polymers	12	04	06	04	14
V	Phenol	12	04	06	04	14
VI	Pulp and Paper	08	02	04	04	10
Total		**64**	**16**	**30**	**24**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of UOs. 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

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Identify engineering problems based on real world problems and solve with the use of free tutorials available on the internet.
b. Use software's and digital resources for related topics.

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/sub topics.

b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the LOs/COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.

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. **Visit to Distillery plant :** Visit nearby distillery plant and prepare block diagram of process, List of unit operations used, Schematic sketches of each stage of manufacturing processes and process description.
b. **Internet based assignment:** Prepare a power point presentation on a topic " List of organic chemicals manufacturing industries in India"
f. Chemical Engineering aspects in Polymer Industry (Internet based assignment): Identify a Polymer Industry, Make the list of product manufactured, make the list of unit operations and unit processes, Describe the identified unit operations and unit processes, Identify the job role for a chemical engineer in Polymer industry, Safety precautions.
g. Collection of different Polymer sample from market. (Field assignment) : Collect two samples from four companies. Classify the samples on the basis of content. identify the location of industry, Prepare a report based on content and cost
h. Collection of different types of soap and detergent samples Collect two samples from four companies. Classify the samples on the basis of content. identify the location of industry, Prepare a report based on content and cost
i. Visit to Pulp and Paper industry. Visit nearby Pulp and paper plant and prepare block diagram of process, List of unit operations used, Schematic sketches of each stage of manufacturing processes and process description.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Dryden's outline of	Gopal Rao, M. and	East West Publisher, London, 2010.

S. No.	Title of Book	Author	Publication
	Chemical Technology.	Sitting, Marshal	ISBN: 9788185938790,
2	Shreve's Chemical Process Industries.	Austin, George T.	McGraw-Hill Book Company, U.S.A.1984; ISBN: 9780070571471
3	Unit Process of Organic synthesis.	P.H.Groggins	Mc Graw Hill International, New york, 1958 ISBN: 8185938792
4	Reactions and Synthesis	Francis A. Carey, Richard J. Sundberg	Springer, Oxford, 2012, ISBN: 1-4613-9798-7

14. SOFTWARE/LEARNING WEBSITES

a. www. people.clarkson.edu
b. www.creatingtechnology.org
c. www.pafko.com/history
d. www.thechemicalengineer.com/
e. www.iisc.ernet.in
f. www.tep.engr.tu.ac.th
g. www.ichemeblog.org/
h. https://www.acs.org/chemicalsafety
i. www.chemistry.harvard.edu