GUJARAT TECHNOLOGICAL UNIVERSITY(GTU)

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

CourseTitle: Chemical Process Technology
(Course Code: 4330504)

Diploma programme in which this course is offered	Semester in which offered
Chemical Engineering	Third

1. RATIONALE

The importance of this subject arises from the need of providing comprehensive and balanced understanding of essential link between chemistry and the chemical industry. It is vital to develop simple but meaningful flow diagram for each chemical product which a student can understand. This course develops skill for arranging and understanding treatment, reaction and separation steps in a flow diagram for variety of chemicals including acids, chloro-alkalis, fuels and industrial gases, cement, lime, polymer, dyes and intermediates, pharmaceutical, fermentation, pesticides, Soap and detergents, fertilizerand many other products. Diploma holders utilize this skill to read and recognize each steps of process flow diagrams during their job. The area of job may be production, R and D, design, technical services, project development, sales and marketing etc.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies:

- Synthesize reactions and unit operations steps to develop and operate a chemical plant to manufacture important chemicals.

3. COURSEOUTCOMES(COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

At the end of the course, a student will be able to

1) Explain the classification and properties of various chemicals
2) Apply concept of the manufacturing processes of various chemicals with neat sketch to operate chemical plant.
3) Identify major engineering problems encountered in manufacturing processes.
4) Suggest applications of various chemicals.

4. TEACHING AND EXAMINATION SCHEME

TeachingScheme (InHours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30*	70	25	25	150

(*):Out of 30marks under the theory CA,10marks 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 theCOs.

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

5. SUGGESTEDPRACTICALEXERCISES

The following practical outcomes(PrOs) arethesubcomponents oftheCOs. *These PrOs need to be attained to achieve theCOs.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Standardize Sulfuric Acid Solution	I	2
2	Preparation of Hydrated Lime	I	2
3	Preparation of Caustic Soda	I	2
4	Preparation of Potassium Chloride	I	2
5	Preparation of Phenol Formaldehyde	II	2
6	Find out Acid Value of Oil	III	2
7	Preparation of Vegetable Oil from Seed	III	2
8	Preparation of Soap	III	2
9	Preparation of Detergent Powder	III	2
10	Preparation of Alcohol	III	2
11	Find out moisture, volatile matter and ash content in fuel	IV	2
12	Determine Calorific Value of Fuel	IV	2
13	Preparation of Aspirin	V	2
14	Prepare of Nitrobenzene	V	2

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher todevelop the industry-relevant skills/outcomes to match the COs. The above table is only a suggestive list. Course teacher can select any 14 practicals.*

i. *The f**ollowing are some sample**'Process'and'Product'related skills(more may be added/deleted depending on the course) with approximate percentage weightage that occur in the above listed **Practical Exercises** of this **course** required which are embedded inthe Cos and ultimately the competency.*

Sr.No.	*SamplePerformanceIndicatorsforthePrOs*	*Weightage in %(Approximate)*
1	*Prepare experimental set up accurately.*	*10*

2	*Use apparatus for precise measurement*s.	20
3	Practice and adapt good and safe measuring techniques.	10
4	Good Record keeping of the observations accurately.	20
5	Interpret the results and theirconclusion.	20
6	Prepare Report in prescribed format	10
7	Viva-Voce	10
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 procuremen to them by the administrators/management of 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.	EquipmentNamewithBroadSpecifications	PrO.No.
1	**HotAirOven:** Temperature is controlled by digital temperature indicator cumcontroller from ambient to 250°C with ± 0.1°C Accuracy. Powersupply: 220/230V, 50Hz single phase, Capacity (Approx.): 50 – 100 liter, Type of Shelves: 03, Material of Inner Chambers: SS304, Material of Outer Chamber: MS with powder coated paint,MaterialofShelves:SS wire mesh.	All
2	**LaboratoryWeighingBalance:** Type of Laboratory Balance: Analytical, Sensitivity (mg): 1 mg,Maximum Capacity of weighing (grams): 200 g, Shape of PAN:Circular, PowerSupply: Single Phase,Display: LED.	All
3	**HotPlateWithMagneticStirrer:** NumberofstirringPositions:1,Calibration:AutomaticCalibration,Magnetic stirrer with a hot plate, Speed Control Accuracy of setspeed (+/-) (RPM): 5, Maximum Stirring capacity per position:3000ml,TopplateMaterial:Stainlesssteel	All
4	**Lab cooling bath**: 220V/50HZ, 1.5KW, 370*340*480mm	All
5	**Bomb calorimeter** Model CC01/M3,, Iso-Thermal, BS 1016: Part 5:1967 IS: 1359–1959 IP 12/63T	12
6	**Grinder**: 230V 50Hz, 950 W, 11000 rpm, 1.8 K	07
7	**Oil making machine :** 3-6 Kg/Hr, 600 W, Gear Box, 400x160x360mm	07
8	**Hand blender: 200w**	09
9	**Crucible and designator :** white ceramic melting crucible , Dish cup 55mm for high temperature refining,	11
10	**Furnace :** Digital Muffle Furnace, 220-230V, 900°C, 25x125x250mm	11

11	**Fermentator:** 22 x 40 x 38 cm (W x D x H), LDC 4 x 40 digits with backlight, Pyrex glass with 5 to 8 side necks (culture volumes from 35 ml to 6 l)	11

7. AFFECTIVE DOMAIN OUTCOMES

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

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

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

i. 'ValuingLevel'in1st year
ii. 'Organization Level'in2nd year.
iii. 'Characterization Level'in3rd year.

8. UNDERPINNINGTHEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom'staxonomy* that are formulated for development of theCOs 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	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Inorganic Chemical Industries	1a. Classify Various Chemical Industries 1b. Describe Properties & Uses of Chemicals 1c. Prepare Flow Diagram and Explain Manufacturing Process 1d. Explain Major Engineering Problems	1.1 Classification of Chemical Industries 1.2 Physical Properties, Application, Manufacturing Process and Major Engineering Problem of 1.2.1 Sulphuric acid 1.2.2 Soda ash 1.2.3 Caustic soda 1.2.4 Cement 1.2.5 Lime 1.2.6 Urea 1.2.7 Elemental phosphorus 1.2.8 Potassium Chloride
Unit-II Polymer Industries	2a. Classify Polymer 2b. Explain application & uses of polymer 2c. Prepare Flow Diagram and Explain Manufacturing Process	2.1 Classification of Polymer 2.2 Explain Physical Properties, Application & Manufacturing Process of 2.2.1 Polyethylene 2.2.2 Styrene butadiene rubber

		2.2.3 Phenol formaldehyde
Unit -III Natural Product Industries	3a. Define fat and oil, carbohydrates, pulp & paper 3b. Describe physical properties of oil & fat 3c. Describe fermentation types 3d. Prepare Flow Diagram and Explain Manufacturing Process 3e. Explain Major Engineering Problems 3f. Explain Role of Biotechnology	3.1 Definition and Physical Properties of Fat & Oil 3.2 Manufacturing Process of Vegetable oil 3.3 Basics of Carbohydrates 3.5 Manufacturing Process of Sugar with Major Engineering Problem 3.6 Basics of Soap & Detergent 3.7 Manufacturing Process of 3.7.1 Soap 3.7.2 Detergent Powder 3.8 Definition of Pulp & Paper 3.9 Manufacturing Process of Pulp by Kraft Process with Major Engineering Problem 3.10 Manufacturing Process of Paper by Wet Process with Major Engineering Problem 3.11 Types of Fermentation 3.12 Manufacturing Process of Ethanol with Major Engineering Problem 3.13 Role of Biotechnology in Chemical Engineering
Unit –IV Fuel and Industrial Gases	4a. Classify, describe and uses of fuels 4b. Classify Coal 4c. Prepare Flow Diagram and Explain Manufacturing Process 4d. Explain Major Engineering Problems 4e. Describe Explosive and propellant 4f. Explain important of cryogenic technology in chemical engineering	4.1 Fuels: types, sources, uses 4.2 Classification of Coal 4.3 Important industrial gases 4.4 Manufacturing and major engineering problem of 4.4.1 Producer gas 4.4.2 Coke oven gas 4.5 Classify Explosive and propellant 4.6 Important of cryogenic technology in chemical engineering
Unit –V Synthetic Organic Chemical Industries	5a. Classify Pharmaceutical Drugs, Pesticides and Dyes 5b. Explain pesticides formulation 5c. Prepare Flow Diagram and Explain Manufacturing Process 5d. Explain Major Engineering Problems	5.1 Classification of pharmaceutical Drugs based on Their Uses with Examples 5.2 Manufacturing Process and Major Engineering Problem of 5.2.1 Penicilline 5.2.2 Aspirin 5.3 Classify pesticides 5.4 Pesticide formulation 5.5 Manufacturing Process and Major Engineering Problem of 5.5.1 Parathion 5.5.2 2-4 Dichlorophenoxy acetic acid

		5.6 Classification of Dyes 5.7 Manufacturing Process of Nitrobenzene 5.8 Manufacturing Process of Aniline by Reduction of Nitrobenzene

9. SUGGESTEDSPECIFICATIONTABLEFORQUESTIONPAPERDESIGN

UnitNo.	UnitTitle	TeachingHours	Distribution of TheoryMarks			
			R Level	U Level	A Level	TotalMarks
I	Inorganic Chemical Industries	09	04	07	04	15
II	Polymer Industries	05	02	03	03	08
III	Natural Product Industries	14	06	10	06	22
IV	Fuel and industrial gases	05	02	04	04	10
V	Synthetic Organic Chemical Industries	09	03	06	06	15
Total		**42**	**17**	**30**	**23**	**70**

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

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/questionsto assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels(of R, Uand 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 out comes in this course: Students 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 fortheir placement interviews:

a) Prepare a PowerPoint presentation or animation showing different types of chemical manufacturing Process
b) Prepare a model of different chemical product flow diagram
c) Preparation of a table showing the difference between Organic and Inorganic Compounds.
d) Market survey of different Chemical product and compare their physical and chemical properties.
e) Library survey regarding polymers and fertilizers in different industries.
f) Collect different polymers and prepare the chart/ PowerPoint based on their type,properties, and uses.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES(ifany)

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)inundertakingmicro-projects/activities.
c) Different types of teaching methods i.e. video demonstration, activity based learning,casestudy, m-learning need to be employed byteachers to develop the outcomes.
d) Some *of the topics/sub-topics* which are relatively simpler or descriptive are to begiven 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, Vlab, and Olabs may be used to teach for the teaching of different concepts.

12. SUGGESTEDMICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/heart the beginning of the semester.In the first four semesters,themicro-projectare 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.***

Themicro-projectcould beindustry application-based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or moreCOs which are the integration of PrOs, UOs, and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the microproject 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-orientedCOs.

A suggestive listofmicro-projects is givenhere. This should relate highly to the competency of the course and theCOs.Similar micro-projects could be added by the concerned course teacher:

a) Prepare a chart of the properties of given product
b) Prepare a chart to demonstrate manufacturing process.
c) Prepare a report on major engineering problem of given manufacturing process
d) Prepare a chart of application of given products
e) Prepare a power pont presentation on a topic “List of chemicals manufacturing industries in India”
f) Prepare a PowerPoint presentation or animation showing different types of chemical manufacturing Process

13. SUGGESTEDLEARNINGRESOURCES

Sr. No.	Title ofBook	Author	Publication with the place,year,and ISBN

1	Outlines of Chemical Technology, 3rd edition	M. Gopala Rao, Marshall Sittig	Affiliated East West Press (Pvt) Ltd-New Delhi
2	Shreve's Chemical Process Industries, 5th edition	Austin G.T.	McGraw Hill publication – New Delhi
3	Chemical Technology – Vol. I and II, 2nd edition	G.N. Pandey and Shukla	Vani Books Company -Hyderabad
4	A Text Book on Petrochemicals, 2nd edition	Rao B. K. B.	Khanna Publishers –New Delhi

14. SUGGESTEDLEARNINGWEBSITES

1. http://www.epa.gov/sectors/sectorinfo/sectorprofiles/chemical.html
2. www.emis.vito.be/sites/default/Bref_**cement**_and_**lime_production**.pdf
3. www.docbrown.info/page04/Mextract.htm
4. http://www.contentshoppe.com/images/eLearning/sample2.swf
5. http://www.auroma.in/propertiescoal.pdf
6. www.naturalproductsexpoindia.com/
7. www.andritz.com/pulp-and-paper/pp-pulp-production.htm
8. ewww.linde-gas.com/en/products_and_supply/gases_fuel/index.htm
9. www.iisrp.com/WebPolymers/00Rubber_Intro.pdf
10. http://www.niehs.nih.gov/health/topics/agents/pesticides/

PO-COMPETENCY-COMAPPING

Semester III	**Chemical Process Technology (CourseCode: 4330504)**						
	Program Outcomes						
Competency &CourseOutcomes	**PO1 Basic& Discipline-specific knowledge**	**PO2 ProblemAnalysis**	**PO3 Design/development ofsolutions**	**PO4 EngineeringTools,Experimen-tation &Testing**	**PO5 Engineeringpractices forsociety,sustainability& environment**	**PO6 ProjectManagement**	**PO7 Life-longlearning**
CompetencyUseSynthesize reactions and unit operations steps to develop and operate a chemical plant to manufacture	3	2	-	2	2	2	1

important chemicals							
CourseOutcomes CO1:Explain the classification and properties of various chemicals	3	-	-	2	-	2	1
CO2:Apply concept of the manufacturing processes of various chemicals with neat sketch to operate chemical plant.	3	2	-	3	2	2	2
CO3:Identify major engineering problems encountered in manufacturing processes.	2	2	-	-	2	-	-
CO4:Suggest applications of various chemicals.	2	-	-	1	1	-	1

Legend:'**3'**forhigh,'**2**'formedium, **'1'**forlowand**'-'**forno correlationofeachCOwithPO.

COURSE CURRICULUM DEVELOPMENT COMMITTEEGTUResourcePersons

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