GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Fertilizer Technology
(Course Code: 4350505)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5thSemester

1. RATIONALE

Indian economy is dominated by agriculture sector. Synthetic fertilizers are must for producing good crops. Hence it is needed to provide comprehensive and balanced understanding of essential link between chemistry and the synthetic fertilizer industry. It is therefore vital for chemical engineers to understand for each fertilizer product, its flow diagram for Industry production. For this purpose chemical engineers should have skills for arranging treatment, reaction and separation steps in a flow diagram for variety of fertilizers including Nitrogenous fertilizers, Phosphatic fertilizer, Potash Fertilizer, Complex fertilizer and Bio fertilizers is essential. Hence this course is designed to achieve this objective.

2. COMPETENCY

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

- Supervise the different stages in fertilizer production

3. COURSEOUTCOMES(COs)

The theory should be taught and practical's should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain:

i. Apply the concept of unit process and unit operations for manufacturing of various fertilizers
ii. Characterize fertilizers on the basis of different properties.
iii. Identify engineering problems in various fertilizers manufacturing.
iv. Outline applications of various fertilizer.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme(InHours)			Total Credits(L+T+P)	ExaminationScheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	5	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 the COs.

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	**Practical/Exercise** (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Unit No.	Approx. Hrs Required
1	Prepare chart for fertilizer classification with chemical formula and nutrient content	I	02
2	Estimate nutrient content (% N, %P2O, % K2O) in different fertilizers from their chemical formula	I	02
3	Estimate percentage of Nitrogen in Ammonium chloride by substitution method	II	02
4	Estimate percentage of Nitrogen in Ammonium sulfate by substitution method	II	02
5	Estimate percentage of Nitrogen in Ammonium chloride by back titration	II	02
6	Estimate percentage of Nitrogen in Ammonium sulphate by back titration	II	02
7	Analysis of Urea by Formaldehyde method	II	02
8	Estimate percentage of Nitrogen in Ammonium Chloride/Sulphate by Kjeldhal's method	II	02
9	Estimate biuret content in Urea sample by colour comparison	II	02
10	Estimate ratio from Ammonia to Phosphoric acid in DAP	III	02
11	Prepare potassium sulphate	IV	02
12	Prepare potassium chloride	IV	02
13	Prepare potassium nitrate	IV	02
14	Estimate percentage of Nitrogen in DAP by Formaldehyde method	V	02
15	Estimate percentage of Nitrogen in DAP by Kjeldhal's method	V	02
16	Preparation of Organic fertilizer	VI	02
		Total	**28**

Note:

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

ii. The following are some **sample** 'Process' and '#Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr.No.	Sample Performance Indicators for the PrOs	Weight age in %
1	Handling of apparatus for precise measurements	10
2	Record observations correctly	20
3	Practice and adapt good and safe measuring techniques	10
4	Calculations, Interpretation of results and their conclusion.	20
5	Prepare report of practical in prescribed format	10
6	Solve assignment questions.	20

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 procurement of them by the administrators/management of the institutes. This will ensure the conduction of practice in all institutions across the state in a proper ways the desired skills are developed in students.

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	Hot Air Oven: Temperature is controlled by digital temperature indicator cum controller from ambient to 250°C with ± 0.1°C Accuracy. Power supply: 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, Material of Shelves:SS wire mesh	All
2	Laboratory Weighing Balance: 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	Hot Plate With Magnetic Stirrer: Number of stirring Positions:1,Calibration:Automatic Calibration, Magnetic stirrer with a hot plate, Speed Control Accuracy of sets peed (+/-) (RPM): 5, Maximum stirring capacity per position:3000ml,Top plate Material: Stainless steel	All
4	Lab cooling bath: 220V/50HZ, 1.5KW, 370*340*480mm	All
5	Kjeldahl apparatus: Flasks:30ml,50ml,100ml, Heating Element : Kanthal A-1, Heater Watt :200 watt ,Max. Temperature : 350°C	8,16
6	Glassware : Burette, Pipette, Round bottom flask, Conical flask, Beaker, Condensor, Measuring cylinder, Separating funnel.	ALL
7	Accessories: Burner, Stand	All
8	Chemicals: Ammonium chloride, Ammonium sulphate, Urea, DAP,KCL, KOH, NaCl, Indicators	All

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/a team member.
b) Follow ethical practices
c) Observe safety measures
d) Good house keeping
e) Time management
f) Practice environmentally friendly methods and processes.

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

i. 'Valuing Level' in 1st year

ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDER PINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom'staxonomy* that are formulated for development of the Cos 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	Major Learning Outcomes(Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Overview of fertilizer	1a. Justify the need for synthetic fertilizer	1.1 Synthetic fertilizers
	1b. Categorize fertilizers	1.2 Classification of fertilizers
	1c. Explain role of essential elements for plant growth	1.3 Role of essential Elements in plant Growth 1.3.1 Macro elements 1.3.2 Micro elements
	1d. Select the relevant fertilizers for the different types of crops	1.4 Application of fertilizers considering nutrient balance and types of crop
Unit – II Nitrogenous Fertilizers	2a. Describe different properties of ammonia, nitric acid and urea 2b. Prepare synthesis path for manufacturing synthesis gas, ammonia, nitric acid and urea 2c. Describe ammonia synthesis converter 2d. Explain storage and transportation of ammonia 2e Estimate concentration of Nitric acid 2f. Describe the engineering problems of ammonia, nitric acid and urea manufacturing	2.1 Physical, chemical properties and applications of ammonia, nitric acid and urea 2.2 Manufacturing of ammonia synthesis gas 2.3 Explain sketch of ammonia synthesis converters 2.4 Manufacturing of ammonia 2.5 Storage and Transportation of Ammonia 2.6 Manufacturing of Nitric Acid 2.7 Concentration of Nitric acid by Mg(NO3) 2.8 Manufacturing of Urea 2.9 Major engineering problems of ammonia, nitric acid and urea manufacturing
	2g. Describe the manufacturing process	2.10 Manufacturing of 2.10.1 Ammonium nitrate 2.10.2 Ammonium sulphate 2.10.3 Ammonium chloride
Unit – III Phosphatic Fertilizer	3a. Describe various physical, chemical properties and uses of Phosphoric acid 3b. Describe the manufacturing process of Phosphoric acid by Wet process and Electric furnace method 3c. Describe the engineering problems of phosphoric acid 3d. Describe the manufacturing Superphosphate and Triple superphosphate	3.1 Physical, chemical properties and applications of phosphoric acid 3.2 Manufacturing phosphoric acid by Wet Process 3.2.1 Strong sulphuric Acid Leaching 3.2.2 Hydrochloric Acid Leaching 3.2.3 Electric Furnace Process 3.3. Major engineering problems of phosphoric acid 3.4. Manufacturing of Superphosphate

		3.5 Manufacturing of Triple superphosphate
Unit – IV Potassic Fertilizers	4a. Describe physical, chemical properties ,manufacturing and uses of potassium chloride, potassium nitrate and potassium sulphate	4.1 Physical, chemical properties, manufacturing and uses of 4.1.1Potassium Chloride 4.1.2 Potassium nitrate 4.1.3 Potassium sulphate
Unit – V Complex Fertilizer	5a. Explain the manufacturing of NPK,ASP,CAN and DAP fertilizers with sketches	5.1 Manufacturing of 5.1.1 NPK fertilizer 5.1.2 Ammonium Sulphate Phosphate (ASP), 5.1.3 Calcium Ammonium Nitrate(CAN) 5.1.4 Di-ammonium phosphate
Unit – VI Bio Fertilizer	6a. Justify the need for biofertilizers and its benefits 6b. Describe the Nitrogen fixing and Phosphate solubilising biofertilizers 6c. Explain preparation a biofertilizers 6d.Explain organic fertilizers	6.1 Types of Biofertilizers 6.2 Biofertilizers: 6.2.1 Nitrogen-fixing biofertilizers 6.2.2 Phosphate solubilizing biofertilizers 6.3 Preparation of a biofertilizers 6.4 List out organic fertilizers 6.5 Outline advantages of organic fertilizers over conventional fertilizer

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total
			Level	Level	Level	Marks
I	Overview of fertilizer	4	02	02	02	06
II	Nitrogenous Fertilizers	14	06	10	06	22
III	Phosphatic Fertilizer	8	04	06	04	14
IV	Potassic Fertilizers	5	03	04	03	10
V	Complex Fertilizer	6	02	06	02	10
VI	Bio Fertilizer	5	02	04	02	8
	Total	**42**	**19**	**32**	**19**	**70**

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

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/questions to 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, 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 perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

Following is the list of proposed student activities like:

1. Assignments
2. Technical Quiz/MCQ Test
3. Presentation on some course topic

4. I-net based assignments
5. Undertake micro-Project in team/individually

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/subtopics.
b) Guide student(s) in undertaking micro-projects/activities.
c) Different types of teaching methods i.e. video demonstration, activity based learning, case study, m-learning need to be employed by teachers to develop the outcomes.
d) Some *of the topics/sub-topics* which are relatively simpler or descriptive are to be given 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. SUGGESTED MICRO-PROJECTS

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

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 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-oriented COs.

A suggestive list of micro-projects is given here. This should relate highly to the competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher.

1) Prepare a chart of the properties of given product
2) Prepare a chart to demonstrate manufacturing process.
3) Prepare a report on major engineering problem of given manufacturing process
4) Prepare a chart of application of given products
5) Prepare a power point presentation on a topic “List of Fertilizer manufacturing industries in India”
6) Prepare a PowerPoint presentation or animation showing different types of Fertilizer manufacturing Process
7) Library survey regarding fertilizers in different industries
8) Prepare a model of different fertilizers product flow diagram

13. SUGGESTEDLEARNINGRESOURCES

Sr. No.	TitleofBooks	Author	Publication with place, year and ISBN
1	Outlines of Chemical Technology, 3rd edition	M. Gopala Rao, Marshall Sitting	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 , 2nd edition	G.N. Pandey and Shukla	Vani Books Company -Hyderabad
4	BioFertilizers and Organic Farming	Vayas S C and Modi H A	Akta prakashan, Nadiad

14. SUGGESTEDLEARNINGWEBSITES

i. http://nptel.ac.in/courses/103107086/4

ii. http://ijset.com/ijset/publication/v1s6/285-291%20IJSET_PK%20JAGA.pdf

iii.www.gses.com/images/pressreleases/Manufacturing-Process-Fertilizer.pdf

iv. http://nzic.org.nz/ChemProcesses/production/1A.pdf

v. http://tnau.ac.in/eagri/eagri50/SSAC222/lec12.pdf

vi. www.fnca.mext.go.jp/bf/bfm/pdf/Biofertilizer_Manual.pd

15. PO-COMPETENCY-CO MAPPING

SemesterIV	Fertilizer Technology (4350505)						
	POs						
Competency &Course Outcomes	PO1 Basic& Discipline-specific knowledge	PO2 Problem Analysis	PO3 Design/development of solutions	PO4 Engineering Tools, Experiment &Testing	PO5 Engineering practices for society, sustainability & environment	PO6 Project Management	PO7 Life-long learning
Competency	Supervise operation and maintenance of various equipments						
CO1: Apply the concept of unit process and unit operations for manufacturing of various fertilizers	2.00	-	-	-	2.00	-	1.00
CO2: Characterize fertilizers on the basis of different properties.	3.00	2.00	-	3.00	-	2.00	2.00
CO3:. Identify engineering problems in various fertilizers manufacturing	2.00	1.00	-	1.00	1.00	-	-
CO4: Outline applications of various fertilizer.	3.00	2.00	-	3.00	-	2.00	1.00

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email ID
1	Mr. R.P. Hadiya (Lecturer in chemical Engineering)	**G P Rajkot**	----------	rphadiya@yahoo.co.in
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