GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I/II – Semester

Course Title: **Applied Chemistry**
(Course Code: 4300009)

Diploma programme in which this course is offered	Semester in which offered
Metallurgy Engineering	First
Civil Engineering, Ceramic Engineering, Environment Engineering, Mining Engineering	Second

1. RATIONALE

The applied chemistry deals with solving the various issues and problems of industries, the environment, and day-to-day life for the benefit of people at large, through applications of various concepts and principles of chemistry. Applied chemistry helps to develop and enhance the thinking capabilities of the diploma passouts in line with the modern trends in engineering and technology through the inclusion of various creative activities/micro projects etc. Many global problems/issues and their in-depth understanding is addressed through the inclusion of topics of relevance like corrosion, electrochemistry, Water, Chemical Bonding and solutions, Cement, Glasses, Refractories, paints, and varnishes Insulating materials, Polymers, Elastomers, and Adhesives in this course.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competencies through various teaching-learning experiences:

- **Use principles of applied chemistry to solve broadly defined engineering problems.**

3. COURSE OUTCOMES (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:

- Apply the principles of chemical bonding and solutions to solve various engineering problems.
- Solve engineering problems using the concepts of electrochemistry and corrosion
- Use relevant water treatment methods to solve domestic and industrial problems.
- Select appropriate engineering materials like cement, glass, and refractory for industrial applications.
- Choose various types of engineering materials like polymers, Elastomers, and Adhesives for domestic and industrial applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			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 30 marks under the theory CA, 10 marks 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 subcomponents of the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Prepare a standard solution of oxalic acid or potassium permanganate.	I	02
2	Determine the strength of the given sodium hydroxide solution by titrating against standard oxalic acid solution using phenolphthalein indicator.	I	02
3	Standardize potassium permanganate solution by standard oxalic acid solution and estimate ferrous ions.	II	02
4	Determine pH-Values of given samples of Solution by using Universal Indicator and pH-meter.	II	02
5	Determine emf of an electrochemical cell (Daniel cell).	II	02
6	Determine electrochemical equivalent of copper metal using Faraday's first law.	II	02
7	Determine the rate of corrosion for different metals in the given solution.	III	02
8	Determine the rate of corrosion for metal in the solution of different pH.	III	02
9	Estimate total hardness of given water sample using standard EDTA solution.	IV	02
10	Estimate alkalinity of given water sample using 0.01M sulphuric acid solution.	IV	02
11	Determine Total Dissolved Solid (TDS) and Total Suspended Solid (TSS) in a given sample of water.	IV	02
12	Determine the Iron content in a given cement sample using a colorimeter.	V	04

13	Prepare Polystyrene and Bakelite. (Any one)	VII	02
	Total Hrs.		**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.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare experimental setup accurately.	10
2	Use apparatus for precise measurements.	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 their conclusion.	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 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 way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1.	**Digital pH Meter:** Type: Microcontroller Based, Display: LED / LCD / Touch Screen, 3 digits, Calibration: up to 3 points with auto buffer, pH Range (pH): 0.00 to 14.00, +/- 0.05, Power Requirements: 230 V +/- 10, 50 Hz AC, Modes: pH mV- C, Temperature Compensation Type: Automatic, Temperature Compensation Range (Degree C): 0 to 100, Temperature Accuracy (Degree C): +/- 0.3, Resolution (pH): 0.01	4,8
2.	**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: SS	11

S. No.	Equipment Name with Broad Specifications	PrO. No.
	304, Material of Outer Chamber: MS with powder coated paint, Material of Shelves: SS wire mesh.	
3.	**Colorimeter:** Wavelength range: 400-700 nm, Wavelength selection: 8 in built gelatin filters, Measurement ranges: 0 -100 %T, 0 -1.99 Abs (O.D.), 0.1 to 1000 Concentration, Resolution: 1% T, 0.01 Abs (O.D.), 0.1 to 1 Concentration, Display: 3-digit digital display, Accessories: 4 nos. flat bottom test tubes. Power: 230V, 50Hz.	12
4.	**Laboratory weighing balance:** Type of Laboratory Balance: Analytical, Sensitivity (mg): 1 mg, Maximum Capacity of weighing (grams): 200 g, Shape of PAN: Circular, Power Supply: Single Phase, Display: LED.	All
5	**Hot plate with Magnetic stirrer:** Number of stirring Positions:1, Calibration: Automatic Calibration, Magnetic stirrer with a hot plate, Speed Control Accuracy of set speed (+/-) (RPM): 5, Maximum Stirring capacity per position: 3000 ml,Top plate Material: Stainless steel	1,2,3,4,9,10,11, 12

7. AFFECTIVE DOMAIN OUTCOMES

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

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

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. UNDERPINNING THEORY

The major Underpinning Theory is formulated as given below. Many of the higher-level UOs of *Revised Bloom's taxonomy* are mentioned for the development of the COs and competency in the students by the teachers (Higher level UOs automatically include lower level UOs in them). 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 **Atomic Structure, Chemical Bonding and Solutions**	1a. Apply the different atomic theories, models, and principles for structural illustration. 1b. Explain Pauli's exclusion principle, Hund's rule, and Aufbau's rule with examples. 1c. Write the electronic configurations of different elements. 1d. Describe the different types of chemical bonds. 1e. Differentiate among the ionic, covalent, and coordinate compounds based on the type of chemical bonding. 1f. Explain various properties of Materials depending upon bond formation. 1g. Prepare the solution of given concentrations (Normality, Molarity).	1.1. Atomic Structure: Concepts of orbit and orbital, Pauli's exclusion principle. 1.2. Hund's rule of maximum multiplicity, 1.3. Aufbau rule, electronic configuration of atom (up to atomic number 30) 1.4. Chemical Bonding: Concept of chemical bonding, types of chemical bonds, Ionic bond, and its characteristics (example NaCl), Covalent bond and its characteristics (example H_2, O_2, N_2, HF, NH_3, H_2O, CH_4), Coordinate covalent bond (example NH_4^+, H_3O^+), Metallic bond and its characteristics, Hydrogen bonding, its types, and Significance, Intermolecular force of attraction. 1.5. Molecular arrangement in solid, liquid, and gases, Structure of solids - Molecular solid, Ionic solid, Network solid, and Metallic solid. 1.6. Solutions: The idea of solute, solvent, and solution, Methods to express the concentration of solution - Normality, Molarity (*M* = mole per liter), ppm, mass percentage, volume percentage, and mole fraction.
Unit – II **Concepts of Electrochemistry**	2a. Explain the theory of ionization and the factors affecting it. 2b. Describe pH value and its industrial application. 2c. Describe different types of	2.1. Arrhenius theory of ionization. 2.2. Electronic concept of oxidation, reduction, and redox reactions. 2.3. Degree of ionization and factors affecting the degree of ionization. 2.4. Definition of pH, pH of acid, base

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	buffer solutions and their application. 2d. Differentiate electrolyte and nonelectrolyte. 2e. Describe the construction and working of an electrochemical cell and standard hydrogen electrode (SHE) 2f. State the Nernst equation and Faraday's laws of electrolysis and its application. 2g. Use the different electrolysis processes such as electrometallurgy, electroplating, and electrorefining to solve a wide variety of industrial problems	and neutral solution, pH calculations for acid, base, and salt solutions at different concentrations, Importance of pH in various fields. 2.5. Definition of buffer solution, buffer action and types of buffer solution, Application of buffer solution. 2.6. Definition of terms: electrolytes, non-electrolytes with suitable examples, Types of electrolytes. 2.7. Construction and working of Electrochemical Cell. 2.8. Construction and working of Standard Hydrogen Electrodes (SHE). 2.9. Nernst theory of single electrode potential and Nernst equation. 2.10. Electrochemical series. 2.11. Electrolysis, Faraday's laws of electrolysis, 2.12. Industrial application of electrolysis: Electrometallurgy, electroplating, electrorefining.
Unit– III **Corrosion of metals and its prevention**	3a. Describe the various types of corrosion. 3b. Identify the different factors affecting the rate of corrosion. 3c. Explain the various types of protective measures to prevent corrosion. 3d. Select relevant methods to prevent metal from corrosion.	3.1. Corrosion: Dry or Chemical corrosion: Oxidation corrosion-mechanism, Corrosion by other gases. 3.2. Wet or Electrochemical corrosion-H_2 liberation and O_2 absorption mechanism of electrochemical corrosion. 3.3. Galvanic corrosion mechanism. 3.4. Concentration cell corrosion. 3.5. Pitting corrosion, Waterline, and Crevice corrosion. 3.6. Factors affecting the rate of corrosion: Nature of the metal, Nature of surface film, Relative areas of the anodic and cathodic parts, Purity of metal, Temperature, Humidity of air, Influence of pH. 3.7. Internal and external corrosion preventive measures: Modification

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		of environment, Modification of the properties of metal, Use of protective coatings, Anodic and cathodic protection, Modification in design, and choice of material.
Unit– IV **Water**	4a. Classify hard and soft water based on their properties. 4b. Determine the hardness of water by the EDTA method. 4c. Softening the hard water by applying the different water softening methods. 4d. Apply the different treatment methods for the purification of water. 4e. Use the Indian standard specification of drinking water.	4.1 Introduction, Source of water, Hard water and soft water. 4.2 Salts cause water hardness, Unit of hardness, and simple numerical on water hardness. 4.3 Problems caused by the use of hard water in boilers and its prevention. 4.3.1 Scale and sludge, Foaming and Priming, Caustic embrittlement, Corrosion 4.4 Water softening techniques: Soda-lime process, Zeolite process, Ion exchange process, Reverse Osmosis process (R.O.) 4.5 Treatment of Municipal drinking water: Screening, Sedimentation, Coagulation, Filtration, Sterilization of water by chlorination, Break-point of Chlorination. 4.6 Enlist Indian standard specifications of drinking water.
Unit– V **Cements, Glasses and Refractories**	5a. Describe the constituents of cement 5b. Use Portland cement appropriately for engineering applications 5c. Select appropriate glass for use in different engineering applications. 5d. Classify the refractories based on their characteristics for use in a variety of applications.	5.1 Cement, constituting compounds in cement. 5.2 Composition and manufacture of Portland cement. 5.3 Setting and hardening of cement. 5.4 Glass and its general properties. 5.5 Manufacture of glass, variety of glasses and their application. 5.6 Definition of refractories. 5.7 Characteristics and Application of refractories. 5.8 Classification of refractories: Acid, Basic and neutral refractories.
Unit– VI **Paints, Varnishes and Insulating Materials**	6a. Explain the functions of different ingredients of paints. 6b. Differentiate between paints and varnishes 6c. Use different types of	6.1 Definition of paints, the purpose of oil paints, characteristics of oil paints. 6.2 Ingredients of paints: Function and example of each ingredient. 6.3 Varnishes: Types of varnishes,

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	insulating materials based on their properties.	Differentiate between paints and varnishes. 6.4 Insulating materials: Types and properties of Insulating materials. 6.5 Application of Thermal, Acoustic, Waterproofing, and Fireproofing insulating materials.
Unit– VII **Polymers, Elastomers, and Adhesives**	7a. Classify Polymers based on molecular structures and monomers. 7b. Differentiate thermoplastic and thermosetting polymers with examples. 7c. Explain polymerization reactions with examples. 7d. Describe the applications of thermotropic and thermosetting polymers. 7e. Describe the application of biodegradable polymers. 7f. Explain the properties and application of synthetic rubbers. 7g. Explain the process of vulcanization rubber. 7h. Explain the different types of adhesives and their application	7.1. Definition of Monomer, Polymer, and Polymerization. 7.2. Classification of Polymers based on molecular structure: Linear Polymers, branched polymers, Cross-linked polymers. 7.3. Classification of polymers based on Monomer: Homopolymer, Copolymer. 7.4. Classification of polymers based on thermal behavior: Thermoplastics and Thermosetting polymers. 7.5. Types of polymerizations: Addition and condensation polymerization 7.6. Simple reactions involved in the preparation and their properties and application of thermoplastics and thermosetting polymers: Polyethylene, Polypropylene, Polyvinylchloride, Polytetrafluoroethylene (Teflon), Polystyrene, Polyacrylonitrile, Bakelite, Epoxy resins 7.7. Biodegradable Polymers: Introduction, chemical composition, and application: Polyβ-hydroxybutyrate–co-β-hydroxy valerate (PHBV), Nylon-2–nylon-6. 7.8. Rubber: Natural rubber and its properties, Vulcanization of rubber, Synthetic rubber – simple reaction involved in the preparation and their properties and application: Buna-S rubber, Buna-N rubber, Neoprene rubber 7.9. Adhesives: Characteristics, Classification and application of adhesives.

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	Atomic Structure, Chemical Bonding, and Solutions	06	03	03	02	08
II	Concepts of Electrochemistry	07	02	06	04	12
III	Corrosion of metals and its prevention	05	02	04	02	08
IV	Water	07	02	05	05	12
V	Cements, Glasses and Refractories	05	03	05	02	10
VI	Paints, Varnishes and Insulating Materials	05	03	03	02	08
VII	Polymers, Elastomers, and Adhesives	07	03	04	05	12
Total		**42**	**18**	**30**	**22**	**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, U and 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 outcomes in this course: Students should conduct 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 for their placement interviews:

a) Prepare a PowerPoint presentation or animation showing different types of chemical bonds and atomic structures.
b) Prepare a model of an atom with the help of a ball and stick or of any other items.
c) pH Calculations for acid, base, and salt solutions at different concentrations.
d) Preparation of a table showing the different methods used for prevention of corrosion.
e) Solve simple problems on hardness calculation
f) Preparation of a table showing the general chemical composition of cement and glass along with their application.
g) Market survey of different paints, varnishes, insulating materials and compare its properties and applications.
h) Library survey regarding polymers, synthetic rubber, and adhesives used in different industries.
i) Collect different polymers and prepare the chart/ PowerPoint based on their type, properties, and uses.

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 are 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 students ought 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:

a) Prepare a PowerPoint animation that can explain the structure of an atom.
b) Prepare a chart of the modern periodic table which gives information about theatomic number and mass number of different elements.
c) Prepare common salt crystals from NaCl solution
d) Prepare a chart representing compounds and solutions which affect human life positively and negatively.
e) Prepare a model of an atom with the help of a ball and stick or of any other items.
f) Form three groups of students in the class. Consider a hypothetical situation of exchanging/ sharing/giving of different items/belongings and demonstrate the type of ionic, covalent, and co-ordinate bonding amongst the students in a simulated situation. Present your findings.
g) Model of electronic configurations for different atoms (Z=30)
h) Prepare a model to demonstrate the application of electrolysis cells.

i) Collect three metallic strips of Al, Cu, Fe, strips, Place them in different acidic and alkaline solutions of the same concentration. Observe and record the loss in weight of metals due to acidic and alkaline environments. Discuss the findings with your teacher and colleagues.
j) Classify the surrounding corrosion into dry corrosion and wet corrosion.
k) Collect different samples of utensils reinforced materials, iron, copper, brass, bronze, and other alloys. Place them in an open environment under tin shade. Observe the corrosive properties over a period of four weeks. Record your observations. Discuss the findings with your teacher andcolleagues.
l) Collect water samples from different water sources and measure the hardness of the water.
m) Make a table showing the availability of natural rubber in India and show places on the India map.
n) Collect the water sample from different sources of ground and surface water (at least five). Explore the new and simplest softening and water treatment methods and perform the same at your home by creating the different assemblies and manipulative techniques at home. Determine the turbidity and pH of water (using pH paper).
o) Suppose you have been selected at a top diploma engineering college in the metro city. You have been living there for more than three months. Based on your critical observation and experience on the different kinds of activities/ performances, identify the typeof water being used by you. Draw your inferences on the same.
p) Collection of data of various cement, glass, paints, and varnishes available in the market.
q) Make a table showing the availability of natural rubber in India and show places on the India map.
r) Collect different polymers and prepare the chart/ PowerPoint based on their type,properties, and uses.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with the place, year and ISBN
1	Engineering Chemistry	Jain & Jain	Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2015, ISBN: 93-521-6000-2
2	A Textbook of Engineering Chemistry	Dr S. S. Dara & Dr S. S. Umare	S. Chand & Co.(P) Ltd., New Delhi, 2014, ISBN:81-219-0359-9
3	Textbook of Chemistry for Class XI & XII (Part-I & II)	NCERT	NCERT, New Delhi, 2017-18, Class-XI, ISBN: 81-7450-494-X (part-I), 81-7450-535-O (part-II), Class-XII, ISBN: 81-7450-648-9 (part-I), 81-7450-716-7 (part-II)
4	Engineering Chemistry	Shikha Agarwal	Cambridge Uni. Press, New Delhi, 2019, ISBN: 978-1-108-72444-9
5	Understanding Chemistry	C.N.R. Rao	World scientific publishing Co., 2009, ISBN: 9789812836045

S. No.	Title of Book	Author	Publication with the place, year and ISBN
6	Engineering Chemistry	Dr. Vikram, S.	Wiley India Pvt. Ltd., New Delhi, 2013, ISBN: 9788126543342
7	Applied Chemistry Laboratory Practices, Vol. I & II	Dr. G.H. Hunger & Prof. A.N. Pathak.	NITTTR, Chandigarh, Publication, 2013-14
8	Chemistry for Engineers	Rajesh Agnihotri	Wiley India Pvt. Ltd., 2014, ISBN: 9788126550784
9	Fundamental of Electrochemistry	V. S. Bagotsky	Wiley International N. J.,2005, ISBN: 9780471700586

14. SUGGESTED LEARNING WEBSITES

a) http://www.chemguide.co.uk/atommenu.html
b) https://www.visionlearning.com
c) http://www.chem1.com
d) https://www.wastewaterelearning.com/elearning/
e) https://www.capital-refractories.com/
f) https://www.wqa.org/
g) https://ncert.nic.in
h) https://docslib.org/insulation-materials-science-and-application
i) http://www.olabs.edu.in/
j) http://chemcollective.org/activities/type_page/1
k) http://www.presentingscience.com/vac/corrosion/index.htm
l) https://vlab.amrita.edu/index.php?sub=2&brch=190

15. PO-COMPETENCY-CO MAPPING

Semester I/II	Applied Chemistry (Course Code: 4300009)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline-specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency **Use principles of engineering chemistry to solve broadly-defined engineering problems.**	3	2	2	1	1	1	1
Course Outcomes CO1: Apply the principles of chemical bonding and solutions to solve various engineering problems.	3	1	-	1	-	-	1
CO2: Solve engineering problems using the concepts of electrochemistry and	3	1	-	1	1	1	1

Semester I/II	Applied Chemistry (Course Code: 4300009)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline-specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
corrosion							
CO3: Use relevant water treatment methods to solve domestic and industrial problems.	3	1	1	1	1	-	1
CO4: Select appropriate engineering materials like cement, glass, and refractory for industrial applications.	3	1	-	1	1	-	1
CO5: Choose various types of engineering materials like polymers, Elastomers, and Adhesives for domestic and industrial applications.	3	1	-	1	1	1	1

Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. Narendra Makwana, Lecturer in Chemistry	Government Polytechnic, Chhotaudepur	9909911391	ngmakwana@yahoo.com
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NITTTR Resource Persons

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