GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Branch: Chemical Engineering (Green Technology and Sustainability Engineering)

Course/Subject Code: BE04044051

Course/Subject Name: Industrial Chemistry

W. E. F. Academic Year:	2024-25
Semester:	4
Category of the Course:	Basic Science Course

Prerequisite:	Basic concepts of chemistry, stoichiometry, and chemical calculations.
Rationale:	Industrial Chemistry is considered as Basic Science subject.

Course Outcome:

After Completion of the Course, Student will able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Identify and describe reactivity patterns in organic reaction	15
CO-2	Explain theoretical principles underlying molecular structure, bonding and properties	20
CO-3	Describe the importance and relevance of Hard and soft materials and also their characterization, properties and uses in engineering applications.	15
CO-4	Distinguish the difference between the different orders of reaction and apply accordingly.	15
CO-5	Utilize different thermo dynamical laws to explain course of reactions	15
CO-6	Apply the different spectroscopic techniques to explain the inner & surface characteristic of molecules.	20

Teaching and Examination Scheme:

Teaching /Learning Scheme in Hours Per Semester					Total Credits = TH/30	Examination Marks					Total Marks
						Theory Marks		Practical Marks			
L	T	P	PBL*	TH	03	ESE (E)	PA (M)	PA (I)	PBL	ESE (V)	
45	0	30	15	90		70	30	30	30	50	200

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Content	Total Hrs
1	**Physical Properties and Chemical Constitution of matter:** Additive & Constitutive properties: Parachor, Viscosity, Dipole Moment, Molar Refraction, Optical activity, Magnetic properties. Preparation and theory of Solution: Mole Fraction, Normality, Molality, Molarity, Lowering of vapor pressure, Elevation of Boiling point, Depression of Freezing point, Osmosis & Osmotic pressure.	4
2	**General Principle of Organic Reactions:** Electronegativity, Electron Displacement Effect, Fission of Covalent Bond, Reactive Intermediate, Organic Species based on Carbon and Nitrogen, Types of Organic reaction and Mechanism.	5
3	**Stereochemistry::** Optical, Geometrical and Conformational Isomerism: Optical activity, Polarimeter, Specific rotation, Enantiomers, Diasteromers, Optical activity in Lactic and Tartaric acid, R and S configuration of Optically active compound and E and Z designation of Geometrical isomers. Resolution of racemic mixture. Conformations of cyclic and acyclic systems.	4
4	**Introduction to quantum theory for chemical systems/Co-ordination Chemistry (Chemical Bonding):** Wave Mechanical approach of atom, Heisenberg Uncertainty Principle, Schrodinger Wave Equation, Applications to Hydrogen atom, Atomic orbitals & MO theory, Types of Hybridisation, Structure-Bonding and shapes of certain molecules. Understanding of different bonds.	6
5	**The Phase Rule:** Introduction, Phase, Components, Degree of freedom, Derivation of Gibb's Phase, Three & Four Phase-One component system like water, sulphur systems, Two component -Eutectic systems like Silver-Lead, Zinc-Cadmium, Ferric Chloride-Water system	5
6	**Chemical Kinetics:** Introduction, Reaction rate, Units of rate, Rate laws, Order of a reaction, Zero order reaction, Molecularity of a reaction, Pseudo-order reaction, first order reaction with numerical, second order reaction, third order reaction, units of rate constant.	5
7	**Thermochemistry:** Introduction, Internal Energy, Enthalpy of reaction, Endothermic reaction, Exothermic reaction, ΔH *and* ΔE and numerical. Thermo-chemical equations like heat of reaction, heat of combustion, heat of neutralization, heat of transition, Hess's Law of constant heat summation and its application, Experimental measurement of heat of reaction	5

8	**Semi &Non-crystalline/amorphous materials:** Classification, structure and configuration of Ceramics, Refractories & Insulators, polymers, copolymers, liquid crystals and amphiphiles: Silicates, glass transition temperature and viscoelasticity. Nanocomposites: role of reinforcement-matrix interface. Strength on composite behaviour, Biomaterials, material related to catalyst such as zeolites, silica	**5**
9	**Analytical Techniques:** Principles of Electronic, Florescence, NMR & Mass spectroscopy, Surface characterization techniques: SEM and TEM. Introduction to experimental techniques: XRD, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
07	**42**	**11**	**10**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Essential of Physical Chemistry by B. S, Bahl and Tuli., Publisher: S Chand & Co. Ltd, New Delhi
2. A textbook of Physical Chemistry by A S Negi & S C Anand, Publisher: New Age International Publisher Private Ltd. New Delhi
3. A textbook of Organic Chemistry by ArunBahl & B S Bahl, Publisher: S Chand & Co. Ltd, New Delhi.
4. A textbook of Inorganic Chemistry by P L Soni, Publisher: Sultan Chand & Sons, New Delhi
5. Engineering Chemistry by B K. Sharma, Publisher: Krishna Prakashan Media (P) Ltd.
6. Principle of Instrumental Analysis by Douglas A Skoog, F. James Holler, Stanely R Crouch, Publisher: Cencage.
7. Instrumental Method of Chemical Analysis by B K Sharma, Publisher: Krishna Prakashan Media.
8. Materials Science and Engineering: A First Course, byV. Raghavan5th Edition Prentice HallIndia, 2004.

List of experiments:

(At least 10 experiments are to be performed)

1. Determination of pH of given solutions using a pH meter.
2. To determine the strength of a solution of hydrochloric acid by a standard solution of sodium hydroxide by using conductometer.

3. To determine the viscosity and density of liquids.
4. Verification of Beer–Lambert's law using a colorimeter.
5. To determine the turbidity of the given water sample.
6. Estimation of chloride ions by Mohr's method.
7. To determine the hardness of water in a given unknown water sample by EDTA method.
8. To determine percentage of iron in given salt of iron (Ferrous ammonium sulphate).
9. To calculate the heat of solution of a salt.
10. To determine the amount of sulphate ions in the given sample of water gravimetrically.
11. To determine the rate constant of the hydrolysis of Ethyl acetate using an acid as a catalyst.

Major Equipments:

1. UV spectrophotometer
2. pH meter
3. Polarimeter
4. Potentiometer
5. Heating mental
6. Conductometer
7. Weighing balance
8. Turbidity meter
9. Calorimeter
10. Hot air oven.

Open source software and website:

NPTEL, World Wide Web, etc.

- **Activities suggested under Problem Based learning:**

Sl. No.	Name of the activity	No. of hours	Total Hours
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h	10
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h	10
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each.	10
4.	Self learning on-line course	Minimum duration of the course should be 10h.	10

5.	Discussion on research paper based on relevant subject	5 research paper	20
6.	Poster/chart/power point preparation on technical topics		6
7.	Group Discussion on emerging/trending technical topics based on subject		1hr each
8	Real world case studies based learning	Duration of data collection/study = 5h Report preparation = 5h	10

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