

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Physical, Analytical & Inorganic Chemistry
(Code: 3310501)

Diploma Programmes in which this course is offered	Semester in which offered
Chemical Engineering	First Semester

1. RATIONALE

Swift progress in the study of external universe lead to the separation of Chemistry as a special branch of natural science. Chemical changes are always associated with a number of diversified physical changes. Physical chemistry uses the theoretical principles and experimental techniques to investigate the Chemical transformations and Physical changes accompanying them. Many industrial processes that have been developed are the results of Physico-Chemical investigations which are increasingly employed by organic, in-organic and analytical chemists. Inorganic chemistry explains chemistry of qualitative analysis, while analytical chemistry deals with the quantitative analysis. Hence study of physical & Analytical chemistry in engineering branch has become essential. This being a core course provides suitable background for Chemical Engg. Technicians for understanding their respective courses and will make them suitable for their job in industries. Thus good foundation in Chemistry will help the students in their self development, to cope up with continuous flow of innovations.

2. LIST OF COMPETENCIES

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

- i. **Apply basic concept of physical analytical and inorganic chemistry in chemical engineering application**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

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

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I PROPERTIES OF LIQUID	1.1 Explain the different Physical properties of liquids. 1.2 Describe the properties of liquids. 1.3 Different use to determine the properties of liquids	1.1 Physical properties of liquid 1.2 Types of physical properties and Characteristics of each property. 1.3 Definition of the Surface tension, Parachor, Refractive index, Molar refraction, Specific refraction, Viscosity. 1.4 Surface tension and viscosity 1.5 Drop pipette method (Stalagmometer) to determine the Surface tension. 1.6 Ostwald's viscometer to determine viscosity of liquids. 1.7 Refractometer to determine refractive Index of liquid.
Unit– II CHEMICAL KINETICS	2.1 Explain the different reactions & kinetics of reaction. 2.2 Describe about order of reaction 2.3 List the of factors affecting the rate of reaction. 2.4 Solve problems	2.1 Define the terms : 2.1.1 Rate of reaction 2.1.2 Specific reaction rate 2.1.3 Velocity constant 2.2 Molecularity and order of reaction 2.3 Definition the terms : 2.3.1 First order reaction 2.3.2 Half concentration period 2.4 Derivation equation for first order reaction. 2.5 Derivation of equation for second order reaction. 2.6 Half life period for first & second order reaction. 2.7 Problems related chemical kinetics.
Unit– III CHEMICAL THERMO DYNAMICS	3.1 Explain the different types of processes. 3.2 Explain thermodynamic terms like- System, Surrounding etc. 3.3 Explain the laws of Chemical Thermodynamics. 3.4 State Hess's law & its application. 3.5 Differentiate between Exothermic & endothermic of reactions	3.1 System and surroundings, Types of System and suitable illustrations 3.2 Thermodynamic property- extensive and intensive 3.3 First law of thermodynamics. 3.4 Function ,Internal energy, Enthalpy 3.5 Rule of assigning sign to work done(W) and heat transferred (Q) as positive and negative. 3.6 Molar heat capacity- at constant volume (Cv) and at Constant pressure (Cp). the relationship $C_p - C_v = R$ 3.7 Adiabatic change, Isothermal change , Reversible process, Irreversible process 3.8 Derivation equation for Adiabatic Expansion of an Ideal gas. $PV^\gamma = \text{Constant}$ 3.9 Second law of thermodynamics 3.10 Aspects of thermo-chemistry & Phenomenon of heat of reaction. 3.11 Types of heat of reactions – Exothermic and endothermic processes with examples

Unit	Major Learning Outcomes	Topics and Sub-topics
		3.12 State Hess's law of constant heat Summation. 3.13 Problems applying Hess's law.
Unit-IV BASIC CONCEPTS OF CHEMICAL ANALYSIS	4.1 Explain the concept of solubility product and ionic product and its application in inorganic analysis. 4.2 Explain the basic concepts of volumetric analysis. 4.3 Describe basic concepts of chromatography. 4.4 Use chromatograph analysis.	4.1 Basic Concepts: Common ion Effect, Solubility Product, Ionic product, Salt hydrolysis 4.2 State conditions for precipitation Considering I_p and K_{sp} 4.3 Application of H_2S and NH_4Cl in inorganic qualitative analysis 4.4 Volumetric analysis 4.4.1 Acid-base titration 4.4.2 Complex metric titration 4.4.3 Oxidation-reduction titration 4.4.4 Precipitation titration 4.5 Chromatography 4.5.1 Classification of chromatography 4.5.2 (a) Paper chromatography (b) Gas Chromatography
Unit- V SURFACE CHEMISTRY	5.1 Explain basic concepts of colloidal 5.2 Describe the preparation, properties of sol. 5.3 Describe about the purification of sol solutions. 5.4 Explain of Emulsion & its types. 5.5 Explain the Concepts of Adsorption & related terms. 5.6 Use basis concepts of colloids in different application such as smoke precipitation etc.	5.1 Adsorption, Adsorbate, Definition of Adsorbent 5.2 Classification of adsorption: Physical adsorption and Chemisorption 5.3 Types of solution: True solution, Suspension and colloidal solution 5.4 Classification of colloidal solution 5.5 Lyophobic and Lyophilic sol. 5.6 Methods of preparing colloidal Solutions. 5.6.1 Condensation methods 5.6.2 Dispersion methods 5.7 Purification of colloidal solutions 5.7.1 Dialysis 5.7.2 Ultra filtration 5.8 Important properties of colloidal solution and explain the following in details 5.8.1 Scattering of light (Tyndall effect) 5.8.2 Brownian movement 5.8.3 Electrophoresis 5.8.4 Electro osmosis 5.9 Emulsion & Gels. 5.9.1 Types of emulsion 5.9.2 Cleansing action of soap 5.10 Application of colloids Smoke precipitation, Purification of water, Sewage treatment, Leather tanning etc.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit- VI ELECTROMETRIC METHODS OF ANALYSIS	6.1 Explain basic concepts of electrometric 6.2 Explain of construction & Working of electrochemical cells. 6.3 Describe about pH metry & Potentiometry titrations. 6.4 Describe Various aspects of conductometry & Kohlrausch Law of independent Migration of ions.	6.1 Defintion the term ` Electrode ' the Types of Electrodes 6.2 Distinction among the : Inert electrode, Working electrode & Reference electrode; with suitable Illustrations. 6.3 Construction & Working of reference electrode: 6.3.1 Hydrogen electrode 6.3.2 Calomel electrode 6.3.3 Quinhydrone electrode 6.3.4 Glass electrode 6.3.5 Ag/ Agcl/ Kcl electrode 6.4 p^{H} & p^{OH} , give their relationship 6.4.1 Methods used to determine p^{H} of given solution by— - p^{H} paper, - p^{H} meter & - Universal indicator methods. 6.4.2 Problem to ascertain p^{H} and p^{OH} . 6.5 p^{H} metry titration 6.6 Potentiometry titration. 6.7 Various aspects of conductometric titration 6.8 Kohlrausch Law of independent Migration of ions.
Unit- VII PREPARATION OF STANDARD SOLUTION	7.1 Define the terms: Solute, Solvent and Solution. 7.2 Explain different methods of expressing concentration with examples. 7.3 List the types of chemicals & its uses. 7.4 Describe about primary & secondary standard solutions. 7.5 Describe the	7.1 Different methods of expressing concentration. i) Weight/Weight method (W/W) ii) Weight/Volume method (W/V) 7.1.1 Types of W/W methods -Molality (M), -Mole fraction (X), -Parts per million (PPM) 7.1.2 Different types of W/V Methods. i) gms/liter ii) Normality (N) iii) Molarity (M) iv) Formality (F) v) P.P.M. / mg/liter 7.1.3 Problems on them. 7.2 Types of different standards i) Primary standards ii) Secondary standards 7.2.1 Conditions for primary standard 7.2.2 Procedure for preparing primary standard Solution.

Unit	Major Learning Outcomes	Topics and Sub-topics
	methods of preparation of standard solutions.	7.2.3 Primary standard for standardization of i) Acids ii) Bases iii) $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ iv) KMnO_4 & v) AgNO_3 .
Unit– VIII INDUSTRIALLY IMPORTANT COMPOUNDS	8.1 Describe the manufacture and uses of important compounds	8.1 Caustic soda-Manufacture and uses 8.2 Ammonia- Manufacture and uses 8.3 Sulphuric Acid- Manufacture and uses 8.4 Potassium Dichromate- Manufacture and uses

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	PROPERTIES OF LIQUID	04	03	03	04	10
2.	CHEMICAL KINETICS	05	04	04	02	10
3.	CHEMICAL THERMODYNAMICS	08	04	05	04	14
4.	BASIC CONCEPTS OF CHEMICAL ANALYSIS	05	02	03	02	08
5.	SURFACE CHEMISTRY	06	03	03	04	10
6.	ELECTROMETRIC METHODS OF ANALYSIS	06	02	02	03	07
7.	PREPARATION OF STANDARD SOLUTION	04	01	02	02	05
8.	INDUSTRIALLY IMPORTANT COMPOUNDS	04	02	02	02	06
	Total	42	20	21	29	70

Legends:

R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	Exercises/Practical/Experiments
1	All	about Course & Lab.
2	7	Acid-Base titration- Strong acid Vs Strong base using Phenolphthalein as an indicator. Prepare of standard solution.
3	7	Acid-Base titration- Strong acid Vs weak base using methyl orange as an indicator.
4	1	Determine viscosity by Oswald's Viscometer.
5	1	Determine f surface tension by Stalagmometer.
6	1	Determine Refractive Index Using Abbes Refractometer.
7	6	Find out pH value by: <ul style="list-style-type: none"> • Universal indicator method • pH paper pH meter
8	6	Determine the amount of HCl in the given solution by using NaOH solution by pH metrically
9	4,6,7	Redox titration
10	6&7	Titrate NaCl AgNO ₃ Potentiometrically and explain the nature of graph
11	6&7	Titrate HCl NaOH by conductometer and explain nature of graph
12	2&4	Determine the first order reaction.
13	2&4	Determine the second order reaction.
	Note:	Minimum Ten Experiments should be performed by the students from the above given list. OR any Other experiments related to above topics

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- Teacher guided self learning activities.
- Course/topic based internet based assignments.
- Library survey regarding Engineering Material used in different industries.
- Industrial Visits of one or Two Industries.
- Quiz & Brain storming session related to Fuel properties & Utilization of fuel for different purposes.
- Sampling & Testing of water collected from different places.
- These could be individual or group-based.

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Title of Books	Author	Publication
1	Essentials of Physical chemistry	Bahl & Tuli	S. Chand & Co. New Delhi.
2	Principals of Physical chemistry	Puri, Sharma & Pathania	S.N. Chand & Co. Jalandhar
3	Basic Concepts of Analytical Chemistry	S. M. Khopkar	New Age Publication, New Delhi
4	Physical Chemistry	N. B. Singh, Shiva Saran Das & A. K. Singh	New Age Publication, New Delhi
5	Analytical Chemistry Problems & Solution	S. M. Khopkar	New Age Publication, New Delhi
6	Vogel's textbook of quantitative Chemical analysis (including instrumental methods)	Jeffery G.H	E.L.B.S. With Longman
7	Textbook of Physical Chemistry	Glasston & Samuel	Macmillan New Delhi

B. List of Major Equipment/ Instrument

- ph- Meter
- Ostwald's Viscometer
- Potentiometer
- Conductometer
- Stalagmometer
- Glass wares

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Polytechnic Faculty Members

- **Prof. J. C. Patel**, I/C. Head, Dept. of Science & Humanities, Dr. S. & S.S. Ghandhy College of Engineering, Surat
- **Prof. Dr. P. R. Patel**, Head, Dept. of Science & Humanities, N.G. Patel Polytechnic, Bardoli
- **Prof. S. A. Nimakwala**, I/C Head, Dept. of Science & Humanities, Shri. K.J. Polytechnic, Bharuch.
- **Prof. R. R. Patel**, I/C Head, Dept. of Science & Humanities, G.P. Himmatnagar

NITTTR Bhopal Co-ordinator

- **Dr. Anju Rawley** Professor, Dept of Applied Science, NITTTR, Bhopal