Vidyasagar University

Curriculum for Industrial Chemistry (Major)

[Choice Based Credit System]

Semester-III

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-5		**C5T:** Chemo metrics and industrial chemical analysis Techniques	Core Course-5	4	0	0	6	75
		C5P: Practical		0	0	4		
CC-6		**C6T:** Chromatography	Core Course-6	4	0	0	6	75
		C6P: Practical		0	0	4		
CC-7		**C7T:**Electro analytical and Thermo analytical Techniques	Core Course-7	4	0	0	6	75
		C7P: Practical		0	0	4		
GE-3		**TBD**	Generic Elective-3				4/5	75
							2/1	
SEC-1		**TBD**	Skill Enhancement Course -1				2	50
Semester Total							**26**	**350**

L=Lecture, **T=**Tutorial, **P=**Practical, **CC-** Core Course, **TBD -** To be decided, **AECC-** Ability Enhancement Compulsory Course

Generic Elective (GE) (Interdisciplinary) from other Department [Paper will be of 6 credits]. Papers are to be taken from following discipline: **Computer Science/Mathematics/Physics/ Chemistry/Economics**

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (**GE1 to GE4**) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

Semester –III
Core Course (CC)

CC- 5: Chemo metrics and industrial chemical analysis Techniques. Credits 06

C5T: Chemo metrics and industrial chemical analysis Techniques. Credits 04

Course Contents:

Chemo metrics: Accuracy and precision, classification of errors and their minimization. Significant figures and computations. Standard deviation and relative standard deviation.

STANDARDS: ISI, BTS, ISO, EURO, ASTM.

Sampling: Sampling procedures, sampling of bulk materials, techniques of sampling for solids, liquids and gases. Collection and processing of data.

Modern instrumental methods of analysis – Principle, methods, instrumentation, interference and application of following: UV- Visible Spectrophotometry,, IR spectroscopy, Raman spectroscopy, NMR spectroscopy, Electron Spin Resonance (ESR) spectroscopy, Induced Couple Plasma(ICP) spectroscopy, Atomic fluorescence spectroscopy. X-ray fluorescence spectroscopy. Atomic absorption spectroscopy and flame photometry.

Mass Spectrometry – Principle, instrumentation, ionization methods – EL, CI, FAB, arc & spark, photoionization, thermal ionization, induced coupled mass spectrometry, laser induced, photoelectic ionization, SIMS, Mass analyzers – Coupled techniques, GC , FTIR, GCMS (Use of stable isotopes) HPLC-MS.

Neutron diffraction analysis: principle and applications.

Basic principle of electrophoresis.

C5P: Practical Credits 02

A. Spectrophotometry

1. Study of λ_{max} of a sample using a spectrophotometer.
2. To draw calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given compound and estimate the concentration of the same in a given solution.
3. To determine pKa value of phenolphthalein indicator using a spectrophotometer.
4. Estimation of Iron in Vitamin / Dietary Tablets using a spectrophotometer.
5. Estimation of caffeine and benzoic acid in soft drink using a spectrophotometer.
6. Estimation of a mixture of cobalt and nickel using a spectrophotometer.

B. Infrared (IR) spectroscopy

1. IR absorption spectra (study of aldehydes and ketones).
2. Structural characterisation of compounds by infrared spectroscopy.

C. Flame photometry

1. Estimation of macro nutrients (Potassium, Calcium, and Magnesium) in soil samples using a flame photometer.
2. Determination of concentration of Na^+ and K^+ using a Flame photometer.

D. Atomic Absorption Spectroscopy:

1. Determination of calcium, iron, and copper in food by Atomic Absorption Spectroscopy.
2. Determination of calcium in blood by Atomic Absorption Spectroscopy.
3. Determination of calcium, iron, and copper in soil by Atomic Absorption Spectroscopy.

E. Nuclear Magnetic Resonance **(Demonstration)**

CC-6: Chromatography — Credits 06

C6T: Chromatography — Credits 04

Course Contents

1. Introduction, classification of chromatographic techniques - types of Chromatography. Advantage & disadvantage of chromatography techniques.

2. Purification, extraction, separation, sample preparation for chromatography techniques.

3. Detail study of **i)** Adsorption (Column) Chromatography, **ii)** Partition Chromatography - paper and TLC, **iii)** Gas Chromatography - GLC & GC, **iv)** Ion Exchange Chromatography, **v)** High Performance (Pressure) Liquid Chromatography (HPLC).

4. Chromatographic separation- application such as main physical characteristic of chromatography: Solubility, adsorption value, volatility, R_f value, R_x value, nature of adsorption etc.

A. Column Chromatography: Principle and method, theory of development and factors affecting column chromatography.

B. Partition chromatography: i. Paper chromatography: Principle and method of paper chromatography. Experimental details for quantitative analysis and quantitative analysis. Experimental methods like: Ascending and Descending method containing one dimensional and two dimensional methods; circular method and its R_f value, R_x value; circular method. **ii. TLC:** Principle, Method of preparation of chromatoplate, superiority of TLC over other chromatographic techniques, experimental techniques. Application, limitation and scope of TLC.

C. Gas Liquid Chromatography (GLC) and Gas Chromatography (GC): Principle of GLC and GC. **GLC & GC:** Sampling, instrumentation, evaluation, selection and characteristic of carrier gas. Effect of temperature & pressure of gas, application, methodology, limitation and scope. **GC:** Methods, instrumentation and its application. GC-MS and LC-MS-Principle, instrumentation and applications.

D. Ion Exchange Chromatography: Principle, type of resins, properties of Ion Exchange Resins, basic requirement of useful resins, method of separation with illustration curve, application of Ion Exchange Resin. Application of Ion Exchange Resin Chromatography for industry.

E. High Performance (Pressure) Liquid Chromatography (HPLC): Principles, types, sampling methods, instrumentation and applications of High Performance (Pressure) Liquid Chromatography (HPLC).

5. Comparison between various types of detectors used in chromatography.

C6P: Practical **Credits 02**

A. Column chromatography:

1. Separation of mixture of inorganic salts, vitamins, colors of flowers, green leaf pigment by column chromatography.
2. Separation of α, β, ϒ carotene from carrot by column chromatography.
3. Separation of a mixture of dyes by column chromatography.
4. Determination of the void volume of a gel filtration column.

B. Paper chromatography:

1. Paper chromatographic separation of amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) and metal ions (Fe^{3+}, $A1^{3+,}$ Cr^{3+} **Or** Co^{+2}, $Ni^{+2,}$ Mn^{2+} and Zn^{2+}) mixture using spray reagent ninhydrine and aniline phthalate. Measure the R_f value in each case.

2. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

3. To study the presence of lactose in milk by paper chromatography.

C. Thin Layer Chromatography (TLC)

1. Preparation of the TLC plate.
2. Separation of a mixture of Dyes by TLC technique and identify them on the basis of their R_f values.
3. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.
4. Separation of organic and inorganic mixture by TLC.

D. Ion exchange Chromatography

1. Determination of ion exchange capacity of resins.
2. Separation of metal ions from their binary mixture.
3. Separation of amino acids from organic acids by ion exchange chromatography.

E. Liquid Chromatography

1. Quantitative analysis of mixtures by Gas Chromatography.
2. Separation of carbohydrates by HPLC
3. Determination of caffeine in beverages by HPLC

CC-7: Electro analytical and Thermo analytical Techniques Credits 06

C7T: Electro-analytical and Thermo analytical Techniques Credits 04

Course Contents

a. Electro analytical techniques:

Potentiometry, Voltammetry, Colorimetry, Amperometry, Coulometry and Conductometry - Basic principle, methodology, instrumentation and their industrial applications.

Polarography: Basic principles, methodology, current-voltage relationships, residual, migration, diffusion and limiting currents. Dropping mercury electrode, half wave potential, Ilkovik equation, instrumentation, Applications in qualitative and quantitative analysis.

Ion-selective electrodes - Principle, equation for potentials, glass membrane electrodes, gas sensing electrodes. Advantages and application.

b. Thermo analytical techniques:

Basic Principle and methodology and instrumentation of thermal gravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermal mechanical analysis (TMA) and their industrial applications.

C7P: Practical **Credits 02**

1. To estimate the amount of Cl^-, I^- present in a mixture potentiometrically,

2. To determine the pKa of monobasic weak acid using a pH meter.

3. Potentiometric titration of (a) a strong acid by a strong base (b) a weak acid by a strong base (c) Mohr's salt by potassium dichromate.

4. Cyclic Voltammetry of the Ferrocyanide / Ferricyanide Couple.

5. Conductometric measurements:

(a) Determination of the cell constant.

(b) Study the variation of molar conductivity of a strong electrolyte (KCl) and of a weak electrolyte (acetic acid) with concentration.

(c) Conductometric titrations for the following systems:

(i) strong acid - strong base

(ii) weak acid - strong base

6. Polarimeter: Determination of the specific and molar rotation of an optically active substance.

7. Colorimetry **:**

i. Estimation of Chromium ion by colorimetry,

ii. Estimation of Manganese by colorimetry.

iii. Determination of the concentration of ammonia in a given unknown solution by colorimetry.

8. Thermal characterization of the following:

(i) Dolomite (for percentage composition by TGA) **(Demonstration exercise)**

(ii) Polystyrene (for glass transition temperature by DTA) **(Demonstration exercise)**.

Skill Enhancement Course (SEC)

SEC-1: Chemical process economics and Entrepreneurship. Credits 02

SEC1T: Chemical process economics and Entrepreneurship.

Course Contents:

Unit-1: Factors involved in project cost estimation, methods employed for the estimation of capital investment. Capital formation, elements of cost accounting. Interest and investment costs, time value of money equivalence.

Unit-2: Depreciation, methods of determining depreciation. Some aspects of marketing, pricing policy, profitability criteria, economics of selecting alternatives, variation of cost with capacity, break-even point, optimum batch sizes, production scheduling etc.

Unit -3: Need, scope and characteristics of entrepreneurship, special schemes for technical entrepreneurs development (STED), exposure to demand based, resource based, service based. Import substitute and export promotion industries, criteria for principles of products selection and developments.

Unit - 4: Choice of technology: plant and equipments. Techno - economic feasibility of the projects. Plant layout and process planning for the project.

Unit -5: Financial institutions, their procedure and incentives, financial ratio and their significance. Books of accounts, financial statements and Funds flow analysis. Energy requirement and utilization.

Unit-6: Resources management: men, machine and materials. Creativity and innovations. Problem solving approach. Strength, weakness, opportunity and threat (SWOT) techniques.

Unit -7: Quality control, quality assurance and testing of the product. Packaging and advertising. After sales service.

Unit -8: Sickness in small scale industries and their remedial measures. Licensing and registration. Important provisions of Factory Act, sales of goods Act, partnership Act.

Or

SEC-1: Basics of computer programming in C and its applications in chemistry

Credits 02

SEC1T: Basics of computer programming in C and its applications in chemistry

Course Contents:

Unit-I: Basic computer organization, processor and memory – main memory, secondary storage devices and storage hierarchy. Software - relationship between hardware and software – types of software. Planning the computer program - algorithm and flowcharts. Basics of operating systems.

Unit-II: Computer languages – machine language, assembly language, assembler, compiler, interpreter and programming languages - C language – introduction, C compiler, operating systems and preprocessor directives - variables, constants, operators, input and output functions.

Unit-III: Control structures – conditional, looping, goto, break, switch and continue statements, functions, arrays and pointers.

Unit-IV: Applications in Chemistry – calculation of the radius of the first Bohr orbit for an electron, calculation of half-life time for an integral order reaction, calculation of molarity, molality and normality of a solution, calculation of pressure of ideal or Vanderwaal's gas, Calculation of electronegativity of an element using Pauling's relation.

Unit-V: Applications in Chemistry - Calculation of empirical formulae of hydro carbon, calculation of reduced mass of a few diatomic molecules, determination of the wave numbers of spectral lines of hydrogen atom, calculation of work of expansion in adiabatic process, calculation of pH, solubility product and bond energy using Born - Lande equation, calculation of standard deviation and correlation coefficient.

Or

SEC-1: Intellectual Property Rights (IPR) **Credits 02**

SEC1T: Intellectual Property Rights (IPR)

Course Contents:

Unit-1: Introduction to Intellectual Property: Historical perspective, Different types of IP, importance of protecting IP.

Unit-2: Copyrights: Introduction, how to obtain, differences from patents.

Unit-3: Trade Marks: Introduction, how to obtain, different types of marks – collective marks, certification marks, service marks, Trade names, etc. differences from Designs.

Unit-4: Patents: Historical perspective, basic and associated right, WIPO, PCT system, traditional knowledge, patents and healthcare – balancing promoting innovation with public health, software patents and their importance for India.

Unit-5: Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India

Unit-6: Industrial Designs: Definition, how to obtain, features, International design registration.

Unit-7: Layout design of integrated circuits: Circuit boards, Integrated chips, Importance for electronic industry.

Unit-8: Trade Secrets: Introduction and historical perspectives, scope of protection, risks involved and legal aspects of Trade Secret Protection.

Unit-9: Different International agreements: (a) Word Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement, (ii) General Agreement on Trade related Services (GATS), (iii) Madrid Protocol, (iv) Berne Convention, (v) Budapest Treaty.
(b) Paris Convention
WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity

Unit-10: IP Infringement issue and enforcement – Role of judiciary, Role of law enforcement agencies – police, customs etc. Economic value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian context – various laws in India licensing and technology transfer.