

# Vidyasagar University

## Curriculum for Industrial Chemistry (Major) [Choice Based Credit System]

### Semester-IV

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-8		C8T: Introduction to Chemical Engineering and Mass Transfer Operations	Core Course-8	4	0	0	6	75
		C8P: Practical		0	0	4		
CC-9		C9T: Fluid Mechanics and Heat Transfer	Core Course-9	4	0	0	6	75
		C9P: Practical		0	0	4		
CC-10		C10T: Industrial Instrumentation and Process Control	Core Course-10	4	0	0	6	75
		C10P: Practical		0	0	4		
GE-4		TBD	Generic Elective-4				4/5	75
							2/1	
SEC-2		TBD	Skill Enhancement Course -2				2	50
<b>Semester Total</b>							<b>26</b>	<b>350</b>

**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.

## List of Core Courses (CC) and Electives

### Core Courses (CC)

**CC-8:** Introduction to Chemical Engineering and Mass Transfer Operations  
**CC-9:** Fluid Mechanics and Heat Transfer  
**CC-10:** Industrial Instrumentation and Process Control

### Skill Enhancement Courses (SEC)

**SEC-2:** Chemical Technology & Society  
**Or**  
**SEC-2:** Management, Costing and Plant Design  
**Or**  
**SEC-2:** Chemical sensors & Biosensor

**Semester -IV**  
**Core Course (CC)**

**CC-8: Introduction to Chemical Engineering and Mass Transfer Operations**  
**Credits 06**

**C8T: Introduction to Chemical Engineering and Mass Transfer Operations      Credits 04**

**Course Contents:**

**Unit-I: Distillation:** Boiling and distillation, vapor-liquid equilibria, Rault's law & Henry's law, relative volatility, azeotropic mixtures, flash distillation, steam distillation, vacuum distillation, fractional distillation, plate columns (Bubble cap, Sieve plate & Valve plate).

**Unit-II: Gas Absorption:** Definition, examples, comparison of absorption and distillation, conditions of liquid- gas equilibrium, solution criteria for gas absorption, mechanically agitated vessels. Packed columns, and plate columns, (Characteristics of tower packing, Types of packing) merits of plate & packed tower.

**Unit-III: Evaporation:** Types of evaporators, jacketed, horizontal and vertical tube evaporators, forced circulation evaporation, entrainment separators (upturned, deflector type, tangential type), effect of scale formation, and multiple effect evaporators.

**Unit-IV: Filtration:** Filtration, Rate equation, Filter media and filter aid, Classification of filters, filter press, Industrial Filters-Sand filter, Plate & frame filter, Leaf filter, Rotary filter and Centrifugal Filtration.

**Unit-V: Sedimentation:** Batch and continuous sedimentation, Thickeners, Separation of solids based on specific properties. Clarification equipments. Cyclones. Froth flotation and Jigs.

**Unit-VI: Mixing:** Mixing, Types of mixing problems, Mixing liquids with liquids, mixing liquids with solids, Mixing solids with solids, Mixing viscous masses. Conveyors and elevators - Introduction Belt conveyor, Conveyor, Screw conveyor, Pneumatic conveyor.

**Unit-VII: Separation :** Size reduction and size separation, Primary and secondary crushers, Fine grinders, Methods of operating crusher, Size separation of solids, Industrial screens, Air separation method, Size separation by laws of setting.

**Unit-VIII: Extractions:** Liquid equilibrium, Extraction with reflux, Extraction with agitation, equipment, it's use and performance, continuous contact equipment, agitator extractors, packed spray extractors, Leaching, flow sheets of solid-liquid extraction, continuous leaching, counter current extraction. Leaching and liquid liquid extraction, Factors affecting rate of leaching and

extraction, Industrial extractors, leaching of cellulose material and fine solids, mechanical agitators. Batch and continuous type equipments liquid extractor, solvents for extraction.

**Unit-IX: Drying:** General Principles (Significance, moisture content), Rate of drying (Constant & falling rate period, factors affecting drying), Drying equipments, Tray dryers, Rotary dryers, Single Drum dryer & Spray dryers.

**Unit-X: Crystallization:** Growth of Crystal, saturation, nucleation super saturation, (Mier's theory), Caking of crystals, effect of impurities, Classification of crystallizers, Agitated tank, Swenson walkers, Krystal, Oslo, continuous vacuum crystallizers.

### C8P: Practical

**Credits 02**

1. **Unit Process :** One or two Examples of each of the following unit process- Nitration, Sulphonation, Friedel-Crafts, reaction, esterification, hydrolysis, oxidation, halogenations, chlorosulphonation reduction, Polymerization, reaction of diazonium salts.
2. Simple laboratory techniques: Crystallization, fractional, crystallization, distillation, fractional distillation, boiling point diagram. Preparation of standard solution: Primary & Secondary standards, determination of  $H_2SO_4$  &  $H_3PO_4$  in a mixture.
3. Extraction processes: Phase diagram, partition co-efficient.
4. Study of types of distillation-Simple distillation, Rectification, Steam distillation.
5. Study of yield of crystallization with seeding and without seeding.
6. Study on evaporation with respect to temperature and surface area.
7. Depression and elevation in B.P/M.P. of solids and liquids. Study of boiling point depression.
8. Study of adsorption behavior.
9. Study of humidity parameter using DBT-WBT method and dew point method.
10. Study of characterization of solid particles by screen analysis. Size reduction of solids using crushers and grinders and product analysis by differential analysis by cumulative analysis.
11. Study on efficiency of separation using cyclone.
12. Study on filtration operation.
13. Study on solid liquid mixing and solid-solid mixing.

### CC-9: Fluid Mechanics and Heat Transfer

**Credits 06**

### C9T: Fluid Mechanics and Heat Transfer

**Credits 04**

#### Course Contents:

**Unit -1: Utilities - Fuel, Air, Boilers, Steam, Pumps:** Fuel: Types of fuels- advantages and disadvantages combustion of fuels composition of fuels. Calorific value, Specifications for fuel

oil orate number, cetane number. Air: Specifications for industrial use. Processing of air. Boilers: Specifications for industrial use, various water treatments. Steam : Generation and use. Pumps: Reciprocating pumps, gear pump, centrifugal pumps.

**Unit -2 :** Fluids & their classification, Viscosity, Newtonian and non Newtonian fluids, Static pressure, Manometer, Mechanism of fluid flow, Types of flow, continuity equation, Bernaulli's theorem, friction factor & friction head. Fluid flow: Basic equation of fluid flow, fans, blowers, compressors, vacuum pumps, ejector.

**Unit -3:** Fluid moving machineries, Equipments, Pipes and pipe fittings, Pumps Classification and Performance, Reciprocating and Rotary pumps, Centrifugal pumps, Blower, Compressors, Vacuum pump.

**Unit- 4:** Flow of Heat: Introduction. Heat transfer: Basic Equation of Heat Transfer. Conduction (Fourier law, Thermal conductivity, thermal insulation & problems), Convection (rate of heat transfer and heat transfer coefficients), Radiation (Absorptive, Reflectivity, & Transmissivity, Kirchoff's law concept of black body & examples). Modes of heat transfer, Fourier's law, Thermal conductivity, Thermal insulators, Resistance in series and parallel ,Heat flow through Sphere and Cylinder, Natural and forced convections.

**Unit - 5:** Natural and forced convections .Heat Transfer equipment . Heat Exchange Equipments: Introduction, Types of Heat Exchanger, Double Pipe Heat Exchanger, Shell& tube Heat Exchanger, Fixed tube, U tube heat exchangers. Extended surface and plate type heat exchanger. Refrigeration cycles.

### **C9P: Practical**

**Credits 02**

1. Determination of Physical constants: Refractive index, surface tension, Effect of surfactants of surface tension, viscosity-fluids, polymer solutions, effect of additives on viscosity, optical rotation.
1. Study of pipe fittings, pumps and flow meter.
2. Pressure measurement in gas line with manometer.
3. Fluid flow study- Reynolds experiment, Differential pressure meter.
4. Study on working of laboratory centrifuge.
5. Study on heat transfer by conduction and convection.

### **CC-10: Industrial Instrumentation and Process Control**

**Credits 06**

### **C10T: Industrial Instrumentation and Process Control**

**Credits 04**

#### **Course Contents:**

**Unit-1:** Temperature: Concept of measurement and accuracy principles, construction and working of temperature measuring instruments- Temperature: Glass thermometers, bimetallic thermometer pressure, spring thermometers, vapor filled thermometers, Expansion thermometer,

thermoelectric temperature measurement, Resistances thermometers, Pyrometers. Radiation pyrometers.

**Unit-2 :** Pressure : Pressure Terms, Concept of measurement and accuracy principles , construction and working of Manometers, barometers, Bourdon pressure gauge ,Bellow type and Diaphragm type pressure gauge ,Vacuum measurement, Calibration of pressure gage, Mcleod gauges, Pirani gauges.

**Unit-3: Liquid Level Direct:** Concept of measurement and accuracy principles, construction and working of Direct and indirect method of liquid level measurement, float type liquid level gauge, ultrasonic level gauges, bubbler system density measurement Sp. Gravity scales, Density and sp. Gravity measurement, Viscosity measurement.

**Unit-4:** Flow measurement – classification of instruments, Concept of measurement and accuracy principles, construction and working of Differential pressure and differential area meters, Open channel flow measurement.

**Unit-5:** Control system, Terminology, Manual and automatic control, Open and closed loop control, Process time lags, Modes of control actions, Final Control Element. Indicators, Recorders, Control panels and Control center, instrumentation diagram, Pneumatic and electrical transmission system.

## C10P: Practical

**Credits 02**

1. Acquaintance with safety measures in a laboratory, Hazard Chemicals.
2. Ore analysis: Dolomite, Limestone, Calcite, Analysis of alloys such as cupronickel.
3. Industrial Analysis: Analysis of common raw materials as per industrial specifications, such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, epoxide, olefins, oil. etc.
4. Calibration of thermometers.
5. Process Instrumentation: Transducers for measuring flow control, Determination of Flash point and ignition points of liquids.
6. Water Analysis: Solid content, hardness, COD and other tests as per industrial specifications.
7. Flow Measuring Device: Flow measuring device - Venturimeter & Orifice meter. Floats monographs of representative raw material such as sulphuric acid, toluene, sodium, carbonate, sodium hydroxide, carbon tetrachloride benzoic acid (5-6 compounds), Limit tests for heavy metals Pb, Mg, Fe and ash content.
8. Flow management in pipes of different materials – effect of drag reducers.
9. Instrumental methods of analysis: Use of calorimeter, pH meter, potentiometer, conductometer, refractometer, polarimeter, Material testing: Testing of alloys, identification of plastic/rubber, estimation of yield point, Young's modulus, flaredness, optical, thermal and electrical properties.

## **Skill Enhancement Course (SEC)**

**SEC-2: Chemical Technology & Society** **Credits 02**

**SEC2T: Chemical Technology & Society**

**Course Contents:**

### **Unit-I: Chemical Technology**

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

### **Unit-II: Society**

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

**Or**

**SEC-2: Management, Costing and Plant Design** **Credits 06**

**SEC2T: Management, Costing and Plant Design**

**Course Contents:**

**Unit-1:** Financial management (source of finance, working and fixed capital). Interest and Depreciation, Taxes and Insurance.

**Unit-2:** Marketing management (core concepts of marketing), Pricing policy, Break Even Analysis, Profitability criteria and selection of alternatives.

**Unit-3:** Project cost estimation, Plant location, Inventory management (methods for calculating economic order quantity), Welfare and Safety.

**Unit-4:** Development of the project, evaluation of a process, choice of process, plant design factors, selection of process equipment and materials, reactors, plant layout.

**Or**

**SEC-2: Chemical sensors & Biosensor**

**Credits 02**

**SEC2T: Chemical sensors & Biosensor**

**Course Contents:**

**Unit-I: Chemical sensors:** Introduction to chemical sensing. Potentiometry: fundamental principles. Applications of potentiometry. Amperometry: fundamental principles. Applications of amperometry : the Clark oxygen electrode, glucose sensors in diabetes, enzyme electrodes, immunosensors, ELISA., Luminescent sensors and electrochemiluminescence. Optical sensors: Selective detection of gases and applications in atmospheric chemistry and environmental science.

Miniaturisation and Lab-on-a-chip devices, elementary idea of MEMS Technology

**Unit-II: Biosensors:** Basics & applications, relevant biology. Optical spectroscopy for biosensing. Optical glucose sensing. Optical Biosensors, Luciferase Biosensors. Electrochemical Biosensors: Potentiometric Biosensors, Amperometric Biosensors. Calorimetric biosensors. Affinity Biosensors: Antibodies and Immunosensors, DNA Sensors,

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