VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE (HONOURS)

MAJOR IN INDUSTRIAL CHEMISTRY

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023& NEP, 2020

VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE (HONOURS) MAJOR IN INDUSTRIAL CHEMISTRY
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. (Hons.)	2nd	III	SEMESTER-III							
			Major-3	INCHMJ03	T: Material and Energy Balance	4	3-1-0	15	60	75
			Major-4	INCHMJ04	T: Industrial aspects of Physical Chemistry	4	3-1-0	15	60	75
			SEC	INCSEC03	P: Chemical sensors & Biosensor	3	0-0-3	10	40	50
			AEC	AEC03	Communicative English -2 (***common for all programmes***)	2	2-0-0	10	40	50
			MDC	MDC03	Multidisciplinary Course -3 (***to be chosen from the list***)	3	3-0-0	10	40	50
			Minor-3 (Disc.-I)	MIN03	***To be decided*** ***(To be taken from other Discipline)***	4	3-0-1	15	60	75
					Semester-III Total	20				375
		IV	SEMESTER-IV							
			Major-5	INCHMJ05	T: Chemo metrics and industrial chemical analysis Techniques P: Practical	4	3-0-1	15	60	75
			Major-6	INCHMJ06	T: Electro analytical and Thermo analytical Techniques P: Practical	4	3-0-1	15	60	75
			Major-7	INCHMJ07	T: Chromatography; P: Practical	4	3-0-1	15	60	75
			AEC	AEC04	MIL-2 (***common for all programmes***)	2	2-0-0	10	40	50
			Minor-4 (Disc.-II)	MIN04	***To be decided*** ***(To be taken from other Discipline)***	4	3-0-1	15	60	75
			Summer Intern.	INT	Internship/ Apprenticeship - activities to be decided by the Colleges following the guidelines to be given later	4	0-0-4	-	-	50
					Semester-IV Total	22				400
					TOTAL of YEAR-2	42				775

MJ = Major, MI = Minor Course, SEC = Skill Enhancement Course, AEC = Ability Enhancement Course, MDC = Multidisciplinary Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical, MIL = Modern Indian Language

MAJOR (MJ)

MJ-3: Material and Energy Balance **Credits 04 (Full Marks: 75)**

MJ-3T: Material and Energy Balance **Credits 04**

Course contents:

Unit I: Dimensions and units:

Basic Chemical Calculations –Atomic weight, Molecular weight, Equivalent weight, Mole, composition of - (i) Liquid mixtures and (ii) Gaseous mixtures, Ideal gas law, Vapour pressure, Humidity and Saturation.

Unit II: Material Balance without Chemical Reactions

Flow diagram for material balance, simple material balance with or without recycle or by-pass for chemical engineering operations such as distillation, absorption, crystallization, evaporation, extraction, etc.

Unit III: Material Balance involving Chemical Reactions

Concept of limiting reactant, conversion, yield, Liquid Phase reaction, Gas Phase reaction with or without recycle or bypass.

Unit III: Energy Balance

Heat capacity of pure gases and gaseous mixtures at constant pressure, sensible heat changes in Liquids, Enthalpy changes

MJ-4: Industrial aspects of Physical Chemistry **Credits 04 (Full Marks: 75)**

MJ-4T: Industrial aspects of Physical Chemistry **Credits 04**

Course contents:

Unit I: Surface Chemistry and Interfacial phenomenon:

Absorption isotherm, sols, Gels, Emulsions, Micro emulsion, Micelles, Aerosols, Effects of surfactants, hydrotropes.

Unit II: Catalysis

Introduction Types – Homogeneous and Heterogeneous. Basic principles, mechanism, Factors affecting the performance, Introduction to phase. Transfer catalysis. Enzyme catalyzed reactions rate model, industrially important reactions.

Unit III: Kinetics

Order, Molecularity, Rate equation for 1st & 2nd order reaction. Effect of temperature on rate constant, energy of activation, Chain reaction.

Unit IV: Thermodynamics

Gibbs Free energy, van't Hoff equation and its application in industry. Gibbs Phase rule. Simple systems equation. Phase equilibrium of H_2O and sulphur. Thermal analysis.

MJ-5: Chemo metrics and industrial chemical analysis Techniques **Credits 04**
(Full Marks: 75)

MJ-5T: Chemo metrics and industrial chemical analysis Techniques **Credits 03**

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.

MJ-5P: Chemo metrics and industrial chemical analysis Techniques (Practical) **Credits 01**

A. Spectrophotometry

1. Study of λmax of a sample using a spectrophotometer.
2. To draw calibration curve (absorbance at λmax 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)**

MJ-6: Electro analytical and Thermo analytical Techniques Credits 04 (Full Marks: 75)

MJ-6T: Electro analytical and Thermo analytical Techniques Credits 03

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.

MJ-6P: Electro analytical and Thermo analytical Techniques (Practical) **Credits 01**

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)**.

MJ-7: Chromatography — Credits 04 (Full Marks: 75)

MJ-7T: Chromatography **Credits 03**

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.

MJ-7P: Chromatography (Practical) **Credits 01**

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 based on 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

MINOR (MI)

TO BE DECIDED (SELECTED FROM OTHER DECIPLINES)

SKILL ENHANCEMENT COURSE (SEC)

SEC 3: Chemical sensors & Biosensor **Credits 03**

SEC3P: Chemistry of Cosmetics & Perfumes **Full Marks: 50**

Course Outline:

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

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,

Laboratory activities: Demonstration of Chemical Sensor & biosensor. Preparation of scientific Model.