Sant Gadge Baba Amravati University, Amravati

THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: INDUSTRIAL CHEMISTRY

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027)
Under Uniform NEP 2020

SYLLABUS

Semester I and II
Semester III and IV
Semester V and VI

Contents

Preamble:

The syllabus of Industrial Chemistry for First year has been redesigned for National Education policy under Choice based Credit System (CBCS) to be implemented form 2024-2025. In CBCS pattern semester system has been adopted for FY, SY and TY which includes Discipline Specific Core Course (DSC) at F. Y. level, Ability Enhancement Compulsory Course (AEC), Discipline Specific Elective Course (DSE) and Open Elective Course (OE), Skill Enhancement Course (SEC), Indian Knowledge Science (IKS), Vocational Skill course (VSC) etc.

It imbibes the guidelines of UGC, UGC LOCF, NEP-2020 and Government of Maharashtra for all its Under Graduate programmes. The Board of Study in Chemistry of the SGB Amravati University prepared the syllabus for the first year undergraduate of Industrial Chemistry. The new curriculum of B. Sc. (Industrial Chemistry) and B. Sc. (Honors with Research) Industrial Chemistry offer courses in the areas of Industrial Chemistry, Material Chemistry, Polymer Chemistry, Unit Operations, Mass Transfer Operations, Physical Chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, Green Chemistry, Unit Processes etc. All the courses are having defined objectives and learning outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offer ample skills to pursue research as career in the field of chemistry and allied areas.

Programme Attributes of a Industrial Chemistry Graduate

Attributes of Industrial chemistry graduate under the outcome-based teaching-learning framework may encompass the following:

- **Core competency:** The Industrial chemistry graduates are expected to know the fundamental concepts of chemistry and applied Chemistry. These fundamental concepts would reflect the latest understanding of the field, and therefore, are dynamic in nature and require frequent and time-bound revisions.
- **Communication skills:** Industrial Chemistry graduates are expected to possess minimum standards of communication skills expected of a science graduate in the country. They are expected to read and understand documents with in-depth analyses and logical arguments. Graduates are expected to be well-versed in speaking and communicating their idea/finding/concepts to wider audience.
- **Critical thinking:** Industrial Chemistry graduates are expected to know basics of cognitive biases, mental models, logical fallacies, scientific methodology and constructing cogent scientific arguments.
- **Psychological skills:** Graduates are expected to possess basic psychological skills required to face the world at large, as well as the skills to deal with individuals and students of various sociocultural, economic and educational levels. Psychological skills may include feedback loops, self-compassion, self-reflection, goal-setting, interpersonal relationships, and emotional management.
- **Problem-solving:** Graduates are expected to be equipped with problem-solving philosophical approaches that are pertinent across the disciplines.
- **Analytical reasoning:** Graduates are expected to acquire formulate cogent arguments and spot logical flaws, inconsistencies, circular reasoning etc.
- **Research-skills:** Graduates are expected to be keenly observant about what is going on in the natural surroundings to awake their curiosity. Graduates are expected to design a scientific experiment through statistical hypothesis testing and other *a priori* reasoning including logical deduction.
- **Teamwork:** Graduates are expected to be team players, with productive co-operations involving members from diverse socio-cultural backgrounds.
- **Digital Literacy:** Graduates are expected to be digitally literate for them to enrol and increase their core competency via e-learning resources such as MOOC and other digital

tools for lifelong learning. Graduates should be able to spot data fabrication and fake news by applying rational skepticism and analytical reasoning.

- **Moral and ethical awareness:** Graduates are expected to be responsible citizen of India and be aware of moral and ethical baseline of the country and the world. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and crime in Indian constitution. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.
- **Leadership readiness:** Graduates are expected to be familiar with decision making process and basic managerial skills to become a better leader. Skills may include defining objective vision and mission, how to become charismatic inspiring leader and so on.

Qualification Descriptors

The qualification descriptors for a Bachelor's degree in Industrial Chemistry may include following:

i. Systematic and fundamental understanding of Industrial Chemistry as a discipline.
ii. Skill and related developments for acquiring specialization in the subject.
iii. Identifying Industrial Chemistry related problems, analysis and application of data using appropriate methodologies.
iv. Applying subject knowledge and skill to solve complex problems with defined solutions.
v. Finding opportunity to apply subject-related skill for acquiring jobs and self-employment.
vi. Understanding new frontiers of knowledge in Industrial Chemistry for professional development.
vii. Applying subject knowledge for solving societal problems related to application of Industrial Chemistry in day to day life.
viii. Applying subject knowledge for sustainable environment friendly green initiatives.
ix. Applying subject knowledge for new research and technology.

(Source: Learning Outcomes based Curriculum Framework (LOCF) for (B.Sc. with Industrial Chemistry) Undergraduate Programme 2020 https://www.ugc.gov.in/pdfnews/0614691_LOCF-chemistry.pdf)

Program Outcomes for BSc

POs:

At the time of graduation, Students would be able to

PO1.Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2.Effective Communication: Speak, read, write, and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media, and technology.

PO3. Social Interaction: Elicit views of others, mediate disagreements, and help reach conclusions in group settings.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological change.

Program Specific Outcomes for BSc (Industrial Chemistry)

PSOs:

Upon completion of the programme successfully, the learners would be able to-

1. Understand the scope, methodology and application of Industrial Chemistry.
2. Apply theoretical and practical concepts of instruments that are commonly used-in most of the chemistry field.
3. Plan and conduct scientific experiments and record the results of such experiments.
4. Get acquainted with safety of chemicals, transfer, and measurements of chemicals, preparation of solutions, and using physical properties to identity compounds and chemical reactions.
5. Describe how Industrial Chemistry is useful to solve social, economic and environmental problem and issues facing our society in energy, medicine, and health

Employability Potential of the Programme:

A degree in Industrial Chemistry is an intelligent choice for future employability and earning potential for learners. Degree program with Industrial Chemistry offers the necessary knowledge, develop skills and nurture creativity to achieve success in virtually any field that's even distantly related in some way to chemistry. A degree in Industrial Chemistry is recognized as a symbol of quality and commitment by employers both inside and outside the chemical industries. Industrial Chemistry provides jobs in cutting-edge technologies within science and research as well as in many fields of distant relations. Industrial Chemistry graduates apply their skills within the areas of environmental sciences, medical fields, scientific equipment sales, science communication, teaching or academic research, a few to mention. Thus, a degree in Industrial Chemistry widens numerous prospects and opportunities for a wide variety of careers in many different fields like science, research, business and health care, etc. Industrial Chemistry inculcates excellent analytical and mathematical skills, which lead to enhanced problem-solving abilities and critical thinking. This improves the likelihoods to secure job in other fields too. Some important skills and abilities honed by Industrial Chemistry learners include:

- Cutting-edge scientific and numerical skills
- Curiosity to understand and solve
- Attention to collect and analyse details
- Patience and determination
- Research and development skills
- Analytical skills
- Use of ICT enabled techniques
- Written and oral communications skills

The thriving and widely recognized branches of Industrial Chemistry like Material Chemistry, Unit Processes, Unit Operations, Mass Transfer Operations, Analytical Chemistry, Green Chemistry, etc. not only expand critical thinking and the ability to understand other scientific and engineering concepts more easily, but also open new horizons to pursue career in different fields. Material Chemistry offers research and development of materials, modify and study materials like Cement, Ceramics, Refractories, Glass for wider use. They also accomplish various scientific studies to identify or find applications for compounds for society. Many industries like Cement, glass, polymer prefer to employ chemists. Unit Processes and mass transfer operations has a greater potential in the fields pharmaceutical, dyes, petroleum Sugar, beverage Industry, etc. It

focusses on solving the fundamental problems associated with designing of the Industrial Equipment's and problems related to energy balance. Analytical chemists find their role for toxicology examinations, quality control and assessment, analysis of pharmaceuticals, investigations for forensic analysis, development of equipment, etc. Analytical chemists work for a particular private or government laboratory or organization, and also develop particular specialties like food technology, forensics or toxicology, to name a few. Green chemistry enhances critical ability and inculcates problem solving skills among the learners regarding sustainable devrelopment. All industries rely heavily on physical parameters for manufacturing and quality assurance of products.

Apart from the technical and specific skills, a Industrial Chemistry graduate also acquires fundamental professional skills throughout the degree program to pursue careers not directly related to the field. These skills include:

- Effective listening and communication skills
- Presentation and interaction skills
- Data collection, analysis and reporting skills
- Modern ICT enabled skills
- Aptitude to work proficiently independently or in a team

Future scope for B.Sc. Industrial Chemistry graduates:

- Prestigious institutions like IIT, NIT, IISER, IISc, BARC, TIFR, a few to mention, offer higher studies such M.Sc. and Ph.D.
- Likewise, foreign Universities also accept Industrial Chemistry graduates for higher studies.
- Industrial Chemistry student can become small or medium scale entrepreneur (own industry).
- Union and State Public service commissions like UPSC, MPSC, Bank Probationary officers, other competitive examinations, etc. offer a multitude of jobs and positions like Drug Inspector, Lab chemist, forensic analyst, etc. for chemistry graduates.
- Students can take teaching jobs at Kendriya Vidyalaya, Navodaya Vidyalaya, High Schools after completing B.Ed. or respective eligibility criteria.
- Laboratory technician in various Public Sector Units like ONGC, IOCL, NTPC, BARC, and Private sector industries.
- Students can become Content Developer for IT industries.
- Students can become Chemical Engineer/Plant Inspector/Quality Control Chemists/ Food Inspector at Food Co-operation of India, Food Safety and Standards etc
- Laboratory technicians to look after sophisticated instruments like IR, Mass Spectrometer, UV-Visible Spectrophotometer, GC, GC-MS, HPLC etc. in research laboratory of academic institutions as well as private sector companies.
- Research Scientist/ Operations Manager/ Chemists / Quality Manager / Research Manager at various industries like Pharmaceuticals, Textile, Cement, Fine Chemicals, Plastic, Drugs, Paint, Dyes, Agricultural sector, etc.
- Employee at Security Printing and Minting co-operation of India
- Employee at Office of Controller general of Patent design and trade work.

Credit Distribution

Three/Four-year UG Degree Programme (Level 4.5 to 5.5)

Vertical	Vertical Type	I	II		III	IV	V	VI	Total Credits	Grand Total
	(i) Three-year UG Degree Programme (Level 4.5.to 5.5)									
A	**Major**	4	4	Major	6	8	8	8	38	**48**
	DSC (60–64)			IKS	2				2	
	(Minimum 50% of Total Credits)	0	0	Elective	0	0	4	4	8	
B	**Minor (from same faculty of DSC) (18–24)**	4	4		4	4	4	4	24	**24**
C	**Generic/Open Elective (OE)** (Faculty-wise basket other than Major/Minor faculty) (10–12)	4	4		2	2	0	0	12	**12**
D(i)	**Vocational Skill Courses (VSEC)** corresponding to Major/Minor (8–10)	0	2		2	2	2	2	10	**16**
D(ii)	**Skill Enhancement Courses (SEC)**	2	2		0	0	2	0	6	
E(i)	**Ability Enhancement Courses (AEC)** (English + Modern Indian Language)	1+1	1+1		1+1	1+1	0	0	8	**14**
E(ii)	**Indian Knowledge System (IKS) 2 Generic**	2	0		0	0	0	0	2	
E(iii)	**Value Education Courses (VEC)** (Understanding India, EVS, Digital & Technological Solution) 4	2	2		0	0	0	0	4	
F(i)	**Internship / Apprenticeship** corresponding to Major 8 **(OJT)**	0	0		0	0	0	4	4	**18**
F(ii)	**Field Projects / Community Engagement & Service (CEP)** corresponding to Major 4-6	0	0		2	2	2	0	6	
F(iii)	**Co-curricular Courses (CC)** (health & wellness, yoga education, sports, fitness, cultural activities, NSS/ NCC & Fine/ Applied/ Visual/ Performing Arts **8**	2	2		2	2	0	0	8	
	Total Credits per Semester	**22**	**22**		**22**	**22**	**22**	**22**	**132**	**132**

(ii) Four-year UG Degree programme (Level 6.0) Honors Degree in Major or Minor A. Honors Degree in Major or Minor					
	Vertical Type		Semester VII	Semester VIII	
	Major (Offered at Three-year UG Programme)	**Mandatory**	**12-14(2*4+2*2 or 3*4+2)**	**12-14(2*4+2*2 or 3*4+2)**	**28**
		Elective	4	4	8
	Research Methodology (RM)		4	0	8
	On the Job Training (OJT)		0	4	4
	Total		**22**	**22**	**44**
	Cumulative		**(132+44) 176**		
(ii) Four-year UG Degree Programme (Level 6.0) B. Honors with Research Degree in Major or Minor					
	Major (Offered at Three-year UG Programme)		**Semester VII**	**Semester VIII**	
		Mandatory	8-10 (*24+2 or 24*)	8-10 (*24+2 or 24*)	20
		Elective	4	4	8
	Research Methodology (RM)		4	0	4
	Research Project (RP)		4	8	12
	Total		**22**	**22**	**44**
	Cumulative		**(132+44) 176**		

Examination and Assessment Process:

i. The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

ii. Exit options are provided with Certificate, Diploma and Basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a Four Years Multidisciplinary Degree Programme. Students will receive a Bachelor's degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.

iii. For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019).

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
A	Major	External & Internal	30/60	9/18	20/40	6/12	50/100	20/40	25/50	10/20	25/50	10/20	25/50	10/20
B	Minor		30/60	9/18	20/40	6/12	50/100	20/40	25/50	10/20	25/50	10/20	25/50	10/20
C	Generic/ Open Elective	Internal			50	20	50	20	--	--	50	20	50	20
D	VSC	Internal			50	20	50	20			50	20	50	20
	SEC	Internal	--	--	50	20	50	20			50	20	50	20
e	AEC (Eng. & One MIL Composite)	Internal			50	20	50	20						
	IKS (Generic)	Internal			50	20	50	20						
	VEC	Internal			50	20	50	20						
F	Internship/ Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. The evaluation/assessment shall be done by appointing external examiner by principal from Industry/Organisation/Academia. The mentor faculty shall be the internal examiner. It shall be evaluated by giving maximum 50 marks per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.											
	FP/CEP													
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).
   - First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
   - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
   - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.
iii. Total Performance in CAT (i.e.40 %) shall be based on the **best two out of three** in CAT examinations
iv. Internal assessment (CAT) shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule

Sr.No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

*****The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.
2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.
3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.
4. Provided that the student shall be eligible to appear for examination if -
   a. He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
   b. He/she has prosecuted a regular course of study in a university department/college affiliated to the University.

c. He/she has in the opinion of the Principal shown satisfactory progress in his/her studies.

5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.
6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

Sant Gadge Baba Amravati University, Amravati

Teaching and Learning Scheme: for the Degree of Bachelor of Science

FACULTY: SCIENCE AND TECHNOLOGY

TLE Scheme for FIRST YEAR: SEMESTER – I (Industrial Chemistry) (Level 4.5)

(As per uniform NEP Scheme)

The Vertical	Type of Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Major / Minor	Theory	120200	Mole Concept and Material Balance	2	2	30	9	20	6	50	20
	Lab/Practical	120201	Industrial Chemistry Lab 1	2	4	25	10	25	10	50	20
Minor / Major	Theory	-	-	2	2	30	9	20	6	50	20
	Lab/Practical	-	-	2	4	25	10	25	10	50	20
Generic/Open Elective	Theory	120202	Cleaning Products I	2	2	30	9	20	6	50	20
	Theory	120203	Herbal Cosmetics I	2	2	30	9	20	6	50	20
VSC	-	-	-	-	-	-	-	50	20	50	20
SEC	Lab/Practical	120204	Industrial Chemistry Lab 2 (Chemistry Lab Operations and Safety Measures)	2	4	-	-	50	20	50	20
AEC - English	Theory		Refer University basket	1	1						
AEC –MIL	Theory		Refer University basket	1	1						
IKS-Generic	Theory		Refer University basket	2	2						
VEC	Theory		Refer University basket	2	2						
CC	Outdoor		Separate SOP will be released	2	4						
TOTAL				**22**	**30**						

TLE Scheme for FIRST YEAR: SEMESTER – II (Level 4.5)

The Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Major / Minor	Theory	120205	Fuels and Energy Balance	2	2	30	9	20	6	50	20
	Lab/Practical	120206	Industrial Chemistry Lab 3	2	4	25	10	25	10	50	20
Major / Minor	Theory		-	2	2	30	9	20	6	50	20
	Lab/Practical		-	2	4	25	10	25	10	50	20
Generic/ Open Elective	Theory	120207	Cleaning Products II	2	2	30	9	20	6	50	20
	Theory	120208	Herbal Cosmetics II	2	2	30	9	20	6	50	20
VSC	Lab/Practical	120209	Industrial Chemistry Lab 4 (Stoichiometry)	2	4	-	-	50	20	50	20
SEC	Lab/Practical	120210	Industrial Chemistry Lab 5 (Formulation of Cleaning Products)	2	4	-	-	50	20	50	20
AEC - English			Refer University basket	1	1	-	-	50	20	50	20
AEC –MIL			Refer University basket	1	1	-	-	50	20	50	20
VEC			Refer University basket	2	2						
CC			Separate SOP will be released	2	4						
TOTAL				**22**	**32**						

*** Important:**

- VSC Should be Complementary to Major/Minor
- SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – III (Level 5.0)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Industrial Chemistry	Major-T	120211	Mass Transfer Operations	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-T	120212	Unit Operations	2	2	30	9	20	6	50	20
Industrial Chemistry	IKS-T	120213	IKS in Industrial Chemistry	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-P	120214	Industrial Chemistry Lab 6	2	4	25	10	25	10	50	20
Industrial Chemistry	Minor-T	120215	Minor Industrial Chemistry 1	2	2	30	9	20	6	50	20
Industrial Chemistry	Minor-P	120216	Minor Industrial Chemistry Lab 7	2	4	25	10	25	10	50	20
Industrial Chemistry	GOEC-T	120217	Green Chemistry Approaches in Agro-Formulations	2	2	30	9	20	6	50	20
Industrial Chemistry	VSC-P	120218	Industrial Chemistry Lab -8	2	4	-	-	50	20	50	20
Industrial Chemistry	FP/CES	120219	Industrial Chemistry Lab 9 (FP / CES in Industrial Chemistry-I)	2	4	-	-	50	20	50	20
Industrial Chemistry	CC		Separate SOP will be released	2	4	-	-	50	20	50	20

Important: * VSC Should be Complementary to Major ** SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – IV (Level 5.0)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Industrial Chemistry	Major-T	120220	Unit Processes I	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-T	120221	Process Equipment's and Solid Waste Management	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-T*	120229*	Unit Processes II	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-P	120222	Industrial Chemistry Lab 10	2	4	25	10	25	10	50	20
Industrial Chemistry	Minor-T	120223	Minor Industrial Chemistry 2	2	2	30	9	20	6	50	20
Industrial Chemistry	Minor-P	120224	Minor Industrial Chemistry Lab 11	2	4	25	10	25	10	50	20
Industrial Chemistry	GOEC-T	120225	Natural and Eco-friendly Dyes	2	2	30	9	20	6	50	20
Industrial Chemistry	VSC-P	120226	Industrial Chemistry Lab 12	2	4	-	-	50	20	50	20
Industrial Chemistry	SEC-P#	120227#	Industrial Chemistry Lab 13	2	4	-	-	50	20	50	20
Industrial Chemistry	FP/CES	120228	Industrial Chemistry Lab 14 (FP/CES in Industrial Chemistry-II)	2	4	-	-	50	20	50	20
Industrial Chemistry	CC		Separate SOP shall be consulted from University website	2	4	-	-	50	20	50	20

* To be implemented w.e.f. academic session 2026-27 # - Only applicable up to academic session 2025-26

Important: VSC Should be Complementary to Major and SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for THIRD YEAR: SEMESTER – V (Level 5.5)

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
5.5	Major-T	120230	Material Chemistry	2	2	30	9	20	6	50	20
5.5	Major-T	120231	Industrial Pollution	2	2	30	9	20	6	50	20
5.5	Major-T	120232	Heavy and Fine Chemicals	2	2	30	9	20	6	50	20
5.5	Major-P	120233	Industrial Chemistry Lab 15	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	120234	Elective Industrial Chemistry-1	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	120235	Industrial Chemistry Lab 16 A (Elective Industrial Chemistry-1)	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	120236	Elective Industrial Chemistry-2	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	120237	Industrial Chemistry Lab 16 B (Elective Industrial Chemistry-2)	2	4	25	10	25	10	50	20
5.5	Minor-T	120238	Minor Industrial Chemistry-3	2	2	30	9	20	6	50	20
5.5	Minor-P	120239	Minor Industrial Chemistry Lab 17	2	4	25	10	25	10	50	20
5.5	VSC-P	120240	Industrial Chemistry Lab -18 VSC (Industrial Materials and Analysis Laboratory)	2	4	-	-	50	20	50	20
5.5	SEC-P	120241	Industrial Chemistry Lab 19 SEC (Process Operations and Analytical Skills Development)	2	4	-	-	50	20	50	20
5.5	FP/CEP	120242	Industrial Chemistry Lab 20 (FP/ CES in Industrial Chemistry III)	2	4	-	-	50	20	50	20
5.5	Non Credit		Foundation of Artificial Intelligence	NC	2			30+20	9+6	50	20

Important:

- **VSC Should be Complementary to Major**
- **SEC must be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**
- As per Sant Gadge Baba Amravati University, Amravati Extra-Ordinary Notification No. No. 241/2025 Dated 24/12/2025 “Foundation of Artificial Intelligence” is the mandatory **Non Credit Course** compulsory course for all the UG students in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati to earn their degree
- NC is Non Credit Course
- Students must select **Any One** of the Major-Elective Courses (T1 to T2) with respective Practical Course in Semester V**.**

TLE Scheme for THIRD YEAR: SEMESTER – VI (Level 5.5)

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
5.5	Major-T	120243	Industrial Safety and Cost Estimation	2	2	30	9	20	6	50	20
5.5	Major-T	120244	Chromatography	2	2	30	9	20	6	50	20
5.5	Major-T	120245	Paper and Pulp	2	2	30	9	20	6	50	20
5.5	Major-P	120246	Industrial Chemistry Lab 21	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	120247	Elective Industrial Chemistry 3 (Green Chemistry and Polymers)	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	120248	Industrial Chemistry Lab 22 A	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	120249	Elective Industrial Chemistry 4 (Instrumentation Techniques)	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	120250	Industrial Chemistry Lab 22 B	2	4	25	10	25	10	50	20
5.5	Minor-T	120251	Minor Industrial Chemistry 4	2	2	30	9	20	6	50	20
5.5	Minor-P	120252	Minor Industrial Chemistry Lab 23	2	4	25	10	25	10	50	20
5.5	VSC-P	120253	Industrial Chemistry Lab 24 VSC	2	4	-	-	50	20	50	20
5.5	Intern/Apprenticeship	120254	FRS Lab 25 Internship /Apprenticeship/ OJT	4	8	-	-	50	20	50	20

Important:

- VSC Should be Complementary to Major has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

Students must select **Any One** of the Major-Elective Courses (T1 to T2) with respective Practical Course in Semester VI**.**

Sant Gadge Baba Amravati University, Amravati

Semester-wise Course Structure, Course Code and Credit distribution and Syllabus for

Faculty of Science and Technology

Degree of Bachelor of Science

Industrial Chemistry

Semester I and II

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-27) Under NEP 2020 (As per Uniform NEP Scheme)

SYLLABUS

Contents

Sant Gadge Baba Amravati University, Amravati

Teaching and Learning Scheme: for the Degree of Bachelor of Science

FACULTY: SCIENCE AND TECHNOLOGY

TLE Scheme for FIRST YEAR: SEMESTER – I (Industrial Chemistry) (Level 4.5)

(As per uniform NEP Scheme)

The Vertical	Type of Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Major / Minor	Theory	120200	Mole Concept and Material Balance	2	2	30	9	20	6	50	20
	Lab/Practical	120201	Industrial Chemistry Lab 1	2	4	25	10	25	10	50	20
Minor / Major	Theory	-	-	2	2	30	9	20	6	50	20
	Lab/Practical	-	-	2	4	25	10	25	10	50	20
Generic/Open Elective	Theory	120202	Cleaning Products I	2	2	30	9	20	6	50	20
	Theory	120203	Herbal Cosmetics I	2	2	30	9	20	6	50	20
VSC	-	-	-	-	-	-	-	50	20	50	20
SEC	Lab/Practical	120204	Industrial Chemistry Lab 2 (Chemistry Lab Operations and Safety Measures)	2	4	-	-	50	20	50	20
AEC - English	Theory		Refer University basket	1	1						
AEC –MIL	Theory		Refer University basket	1	1						
IKS-Generic	Theory		Refer University basket	2	2						
VEC	Theory		Refer University basket	2	2						
CC	Outdoor		Separate SOP will be released	2	4						
TOTAL				**22**	**30**						

TLE Scheme for FIRST YEAR: SEMESTER – II (Level 4.5)

The Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Major / Minor	Theory	120205	Fuels and Energy Balance	2	2	30	9	20	6	50	20
	Lab/Practical	120206	Industrial Chemistry Lab 3	2	4	25	10	25	10	50	20
Major / Minor	Theory		-	2	2	30	9	20	6	50	20
	Lab/Practical		-	2	4	25	10	25	10	50	20
Generic/ Open Elective	Theory	120207	Cleaning Products II	2	2	30	9	20	6	50	20
	Theory	120208	Herbal Cosmetics II	2	2	30	9	20	6	50	20
VSC	Lab/Practical	120209	Industrial Chemistry Lab 4 (Stoichiometry)	2	4	-	-	50	20	50	20
SEC	Lab/Practical	120210	Industrial Chemistry Lab 5 (Formulation of Cleaning Products)	2	4	-	-	50	20	50	20
AEC - English			Refer University basket	1	1	-	-	50	20	50	20
AEC –MIL			Refer University basket	1	1	-	-	50	20	50	20
VEC			Refer University basket	2	2						
CC			Separate SOP will be released	2	4						
TOTAL				**22**	**32**						

*** Important:**

- VSC Should be Complementary to Major/Minor
- SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
A	Major	External & Internal	30/60	9/18	20/40	6/12	50/100	20/40	25/50	10/20	25/50	10/20	25/50	10/20
B	Minor		30/60	9/18	20/40	6/12	50/100	20/40	25/50	10/20	25/50	10/20	25/50	10/20
C	Generic/ Open Elective	Internal			50	20	50	20	--	--	50	20	50	20
D	VSC	Internal			50	20	50	20			50	20	50	20
	SEC	Internal	--	--	50	20	50	20			50	20	50	20
e	AEC (Eng. & One MIL Composite)	Internal			50	20	50	20						
	IKS (Generic)	Internal			50	20	50	20						
	VEC	Internal			50	20	50	20						
F	Internship/ Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. The evaluation/assessment shall be done by appointing external examiner by principal from Industry/Organisation/Academia. The mentor faculty shall be the internal examiner. It shall be evaluated by giving maximum 50 marks per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.											
	FP/CEP													
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the **best two out of three** in CAT examinations

iv. Internal assessment (CAT) shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule

Sr.No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

*The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.
2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.
3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.
4. Provided that the student shall be eligible to appear for examination if -
   a. He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
   b. He/she has prosecuted a regular course of study in a university department/college affiliated to the University.

c. He/she has in the opinion of the Principal shown satisfactory progress in his/her studies.

5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.

The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

Course Category: Major/Minor (Theory) - 1

120200 Mole Concept and Material Balance

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	120200	Mole Concept and Material Balance	2	30	2 Hrs	30+20 = 50

Course Objectives:	1. To understand the various systems of Units. 2. To Understand the stoichiometric equations and its applications. 3. To understand and able to established the material balance equation.
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for the interconversions of units. 2. Able to established individual and overall material balance equations. 3. Able to calculate composition of various mixtures by different methods. 4. Able to established material balance equations.

Unit System	Content	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Dimensions and Units:** Fundamental and derived quantities, base units, derived units and multiple units Systems of Units: FPS, CGS, MKS and SI. Interconversions of units. Problems based on interconversions of units.	8 Hours	8 Marks	**1.Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. **2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. **3.Problem-Solving Sessions**: Organize regular problem-solving sessions where students can apply theoretical knowledge to solve problems. **4.Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions and problem-solving.
Unit II	**A] Mole Concept:** Mole, Atomic weight, Molecular weight, Equivalent weight, Methods of expressing compositions of i) solid mixtures, ii) liquid solutions, iii) gaseous mixtures Problems based on these	7 Hours	7 Marks	
Unit III	**Material Balance without Chemical Reactions:** Distillation, Crystallization, Evaporation, Extraction, Filtration with flow sheet diagram. Problems based on above unit operations.	8 Hours	8 Marks	
Unit IV	**Material Balance with Chemical Reactions:** Stoichiometric equation, Stoichiometric coefficient, Conversion, Yield, Selectivity, Limiting and excess reactants, Problems based on material balance without chemical reactions.	7 Hours	7 Marks	

References:	**Text books:** 1. Unit Operations- I & II by K.A. Gavhane, Nirali Prakashan. 2. Introduction to Process Calculations (Stoichiometry) by K.A. Gavhane, Nirali Prakashan. 3. A Text Book of Physical Chemistry by P.L.Soni, Sultan Chand & Sons. 4. A Text Book of Engineering Chemistry by S. S. Dara, S. Chand and Co. **Reference Books:** 5. Stoichiometry by B. I. Bhatt and S. M.Vora, Tata McGraw-Hill Pub. Co. 6. Chemical Process Principles, Part- I by O. A. Hougen, K. M. Watson, R.A. Ragatz, CBS Publishers. 7. Non-conventional Energy Sources by G.D.Rai, Khanna Publishers. 8. Principles of Physical Chemistry by B.R. Puri, M.S. Patahnia and L.R. Sharma, Vishal Publishing Co. 9. Engineering Heat Transfer by Gupta and R. Prakash, Nem Chand and Bros. **Web Resources** 1. https://pdhonline.com/courses/m239/m239content.pdf 2. https://archive.nptel.ac.in/courses/103/105/103105209/ 3. https://onlinecourses.nptel.ac.in/noc20_bt07/preview
Model Questions:	**Short Type** 1. Define Base Units. 2. What are derived units? Give two examples. 3. Problems based on Interconversions of Units. 4. Prove that sum of all the mole fractions is unity. 5. Discuss weight fraction. 6. Discuss Mole percent. 7. Give an account of Mole Fraction. **8.** Give the SI unit of: a) Density b) Pressure
	Long Type 1. Give the SI Units of a) Power b) Energy c) Enthalpy d) Pressure 2. Discuss Distillation Operation and give the material balance equation. 3. Discuss Evaporation operation and give the individual and overall material balance equation with block diagram. 4. Explain limiting component and excess component with suitable example. 5. Discuss Extraction operation and give the individual and overall material balance equation with block diagram. 6. Discuss evaporation operation with material balance equations and block diagram. 7. Discuss stoichiometric equation and stoichiometric coefficient with suitable example. 8. Explain the term a) Yield and b) Selectivity 9. Problems.

MCQs

1. Length is an example of ---- quantity.
   a) Basic b) derived c) Multiple d) None of these
2. Which of the following is an example of derived quantity?
   a) Length b) Area c) Mass d) Time
3. Which of the following is a basic quantity?
   a) Pressure b) Enthalpy c) Mass d) Density
4. Gram equivalent of solute dissolved in one liter of solvent is called.
   a) Molality b) Molarity c) Normality d) None of these
5. The component which decides the product is called as
   a) Limiting reactant b) Excess Reactant c) Product d) None of these
6. The component of which the requirement is in excess to that of theoretical requirement is called
   a. Limiting reactant b) Excess Reactant c) Product d) None of these
7. Gram moles of solute dissolved in one liter of solvent is called
   a) Normality b) Molality c) Molarity d) None of these
8. One mole of compound is equivalent to its
   a) Atomic weight b) equivalent weight c) molecular weight d) None of these
9. The unit operation which is used to separate two or more than two liquid components from each other by thermal energy is called as
   a. Extraction b) evaporation c) crystallization d) distillation

Course Category: Major Lab-1

120201 Industrial Chemistry Lab 1

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	120201	Industrial Chemistry Lab 1	2	60	4 Hrs	25+25= 50

Course Objectives:	1. To understand the various systems of Units. 2. To Understand the stoichiometric equations and its applications. 3. To understand the various standardization methods.	
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for the interconversions of units. 2. Able to practical knowledge in professional life. 3. Able to perform distillation operation. 4. Able to established mass relation equation.	
Unit System	**Content**	**Incorporation of Pedagogies**
Experiments	1. Problems based on mass relation 2. Numerical problems on units and conversions. 3. Preparation of standard solution of Oxalic acid. 4. Preparation of standard solution of copper sulphate 5. Standardization of sodium hydroxide solution. 6. Standardization of sodium thiosulphate solution 7. Determination of molecular weight of given sample by Rast's method. 8. Problems on material balance. 9. Separation of two miscible liquids by simple distillation. 10. Standardization of $KMnO_4$ Solution.	**Lab Reports:** Students prepare detailed lab reports on their findings. **Discussion Sessions**: Group discussions. **Group Projects**: Assign group projects on stoichiometric methods. **Class Debates**: Discuss the findings amongst the students.
References:	**Text books:** 1. Practical Chemistry, by Ambrish Agarwal, Shivalal Agrawal and Co. 2. Laboratory Manual Chemistry by NCERT 3. GCE Chemistry Practical Handbook Department of Science Faculty of Science and Technology National Institute of Education. 4. Text Book: Practical General Chemistry by Dr. Ahmad Al-Owais & Dr. Abdulaziz Al-Wassil. 5. Laboratory Manual for Engineering Chemistry Practical. 6. Engineering Chemistry Laboratory Manual, Maharaj Vijayaram Gajapathi Raj College of Engineering. 7. Understanding 0 level Chemistry Practical 8. A Textbook on Experiments and Calculations in Engineering Chemistry By S.S Dara. S Chand Ltd. 9. Practical Lab Manual of Pharmaceutical Organic Chemistry – I by Dr. Shivendra Kumar Dwivedi, IP Innovative Publication Pvt. Ltd. **Web Resources:** 1. Standardization of Solution: https://www.youtube.com/watch?v=R1FM4cyIMNM 2. https://www.youtube.com/watch?v=Md67iTTBij0	
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

• Active participation in activities	10 Marks
• Continuous Assessment Tests (CAT) (At least three tests) *	10 Marks
• Submission of duly certified practical record	05 Marks
Total	**25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

• Exercise 1	10 Marks
• Exercise 2	10 Marks
• Viva-Voce (external)	05 Marks
Total	**25 Marks**

Course Category: Generic/Open Elective-1

120202 Cleaning Products I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	120202	Cleaning Products I	2	30	2 Hrs	30+20=50

Course Objectives:	1. To understand the Various cleaning products. 2. To Understand the action of cleaning agents. 3. To identify various cleaning products as per the applications.
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for the preparation of cleaning products. 2. Able to prepare household cleaning products. 3. Able to start small scale business. 4. Able to understand the science behind cleansing action.

Unit System	Content	Work Load Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Cleaning agents: Introduction, History, Action of cleaning agents, Safe ingredients for homemade Cleaners, uses of cleaning products, classification of cleaning agents. Storage of cleaning agents.	8 Hours	8 Marks	**1.Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. **2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. **3.Problem-Solving Sessions**: Organize regular problem-solving sessions **4.Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions.
Unit II	Natural and Synthetic cleaning agents, chemistry of cleaning action. Chemical compositions of cleaning agents. Preparation, raw material, uses and properties of Floor Polishes and air freshener. There uses and action.	7 Hours	7 Marks	
Unit III	Home Made Cleaners: Introduction, Preparation, raw material, uses and properties of Drain Cleaners, Floor Cleaners and Lime and Mineral deposit remover.	8 Hours	8 Marks	
Unit IV	Preparation, raw material, uses and properties of Metal cleaner and Metal Polishes, Rust Remover, Tub and Tile Cleaner.	7 Hours	7 Marks	

References:	**Text Books:** 1. Home Made Cleaners by Denise G. Dias Johnson Co. Extension Agent, FCS 2. Home Made Cleaning Products by Waste Virginia University. 3. DIY Natural Cleaning by Kristin Marr. 4. Green Tok: The Ultimate Guide to Natural & Reduced Waste Cleaning. 5. Cleaning Science Uttarakhand Open University. **Reference Books:** 1. Advanced Cleaning Product Formulations Volume 5 by Ernest W Flick 2. Homemade Household Cleaners Amanda Griffin and Randall A. Cantrell. **Web Resources:** 1. Cleaning Product Formulation: https://www.ihmnotes.in/assets/Docs/Sem-1/AO/Ch-4,%20CLEANING%20AGENTS.pdf 2. Cleaning Product Formulation: https://www.turi.org/content/download/7355/134087/file/Vida%20Verde%20recipe%20booklet%20-%20English%20-%202016.pdf
Model Questions:	**Short Type** 1. Define Cleaning Agent. 2. Give the uses of cleaning products. 3. Give the chemical composition of cleaning agent. 4. Give the various uses of Floor Polishes. 5. Give the reagents used for preparation of air freshener. 6. What are the properties of good floor cleaner? 7. Give the raw materials used for the preparation of drain cleaner. 8. What are the uses of metal polishes? 9. Give the raw materials used in rust remover.
	Long Type 1. Discuss the history of cleaning products. 2. How will you classify cleaning agents? Discuss in detail. 3. Explain the method of preparation of Floor Polish. 4. Explain the method of preparation of Mineral deposit remover. 5. Discuss the characteristics of mineral deposit remover. 6. Explain the preparation method of air freshener. **7.** What are the characteristics of metal cleaner?
	MCQs 1. Cleaning agents removes a. Stain b. Dust c. Dirt d. All of these 2. Which of the following are major reagents of homemade cleaner? a. Baking Soda b. Enzyme c. Bleaching Powder d. Petrochemical Solvent 3. Disinfectants, detergents, sanitizers are the examples of a. Cosmetics b. Metal polishes c. Air Freshener d. Cleaning agents. 4. The emulsion of water with waxes is called as a. Drain cleaner b. Hair shampoo c. Floor and furniture polish d. None of these 5. Lavender, sandalwood, cinnamons are used in a. Shoe polish b. Drain cleaner c. Air freshener d. Metal polish 6. Mineral deposits are removed by a. Acid b. Waxes c. Oil d. None of these 7. White Vinegar is used to remove a. Dust b. Dirt c. Stain d. All of these 8. The major reagents used in metal polishing are a. White Vinegar b. Baking soda c. Lemon d. All of these

Course Category: Generic/Open Elective - 2

120203 Herbal Cosmetics I

Level	Semester	Course Code	Course Name	Credits	Teaching	Exam	Max

					Hours	Duration	Marks
4.5	I	120203	Herbal Cosmetics I	2	30	2 Hrs	30+20=50

Course Objectives:	1. Students should understand the benefits of Herbal Cosmetics. 2. Students should aware about Global Cosmetic Market 3. Should aware about herbal cosmetic market potential in India. 4. Should aware bout the basics of herbal cosmetics.
Course Outcomes:	After completion of the course student should 1. Able to formulate various herbal cosmetic on commercial basis. 2. Able to overcome the problems arise during formulation. 3. Able to analyzed the formulated product. 4. Able to apply basic knowledge to incorporate innovative ideas in formulation.

Unit System	Content	Work Load Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Herbal Cosmetics in ancient India: Introduction, Raja Serfoji's contribution in formulation of lip balm, skin scrub, cure for dandruff, kayakalpa, face pack, cure for pimple. Global Perspective of Plant-Based Cosmetic Industry: Introduction, Specialty Plant Materials for Herbal Cosmetic Production like Essential oil, dye and colourants, oils Fat and waxes. Indian scenario of cosmetic Industry.	8 Hours	8 Marks	**1.Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. **2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. **3.Problem-Solving Sessions**: Organize regular problem-solving sessions **4.Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions
Unit II	**Formulation of Herbal Cold Creams:** Benefits of Herbal Cold Cream, Functions, desire properties. Formulation method, raw materials, vanishing cream, Evaluation of herbal cream with respect to pH, organoleptic properties, homogeneity, spreadability, dye test, appearance, washability, irritancy test.	7 Hours	7 Marks	
Unit III	**Formulation of Herbal Aloevera Gel:** Benefits of Herbal Aloevera Gel, Functions, desire properties. Formulation Method, raw materials, Evaluation with respect to pH, Homogeneity, Smoothness, Appearance.	8 Hours	8 Marks	
Unit IV	**Formulation of Herbal Sunscreen Lotions:** Benefits of Herbal sun Screen lotion, Functions, desire properties. Formulation, raw materials Composition of Sunscreen lotion**,** Evaluation of formulated sunscreen lotion with respect to physicochemical studies, safety evaluation, irritation test, efficacy analysis.	7 Hours	7 Marks	

References:

Text Books:

1. Textbook of herbal cosmetics by Vaibhav Tripathi, Dinanath Jhade, Niraj Sharma, Rageeb Usman,S. Vikas & Co. Publishers.
2. Textbook of herbal cosmetics by M. Vimaladevi, CBS Publishers & Distributors.
3. Herbal Cosmetics Handbook By Himadri Panda, Asia Pacific Business Press.
4. Herbal Plants used in Cosmetics and Cosmeceuticals and their advantages over the Synthetic Counterparts By Charu Gupta and Dhan Prakash.
5. Text book of Cosmetic Formulations, by Sarah Adinda Puteri.
6. Textbook of Cosmetic Formulations By Sharna Gadhiya and Dhanawat.

Web Resources:

1. Formulation of Cosmetics: https://www.slideshare.net/pharmmuthu/formulation-and-evaluation-of-cosmetic-products

Model Questions:	**Short Type** 1. What is Cosmetic? 2. Give the Specialty Plant Materials used for Herbal Cosmetic Production. 3. List down the benefits of Herbal Cold Cream. 4. Discuss the organoleptic properties of Herbal cold cream. 5. What is dye test for herbal cold cream? 6. Give the Benefits of Herbal Aloevera Gel. 7. Give an account of Homogeneity test for Aloevera Gel. 8. Discuss the advantages of Herbal Sunscreen Lotion.
	Long Type **1.** Give an account of Herbal Cosmetics in ancient India. **2.** Discuss the Raja Serfoji's contribution in formulation of Herbal Cosmetics. **3.** Explain the formulation method of Herbal Cold Cream. **4.** Discuss the Properties of Herbal Cold Cream. **5.** Explain the formulation method of Herbal Aloevera Gel. **6.** Discuss advantages of Herbal Sunscreen lotion over synthetic one. **7.** Discuss methods of evaluation of formulated Sun screen lotion. **8.** Discuss various raw materials used in herbal sun screen lotion.
	MCQs 1. Raja Serfoji is known for his contribution in a. Herbal Medicine b. Herbal Cosmetics c. Allopathic drugs d. Both a and b 2. Which of the following is a part of Herbal Cosmetics? a. Crude oil b. Petroleum c. Mineral oil d. Essential oil 3. The pH value of the Cosmetic Product should be a. 1-2 b. 4.5-7 c. 8-10 d 10- 12 4. Cold cream is used to maintain a. Moisture balance of skin b. Moisture balance of hair c. Dryness d. None of these 5. Which of the following test are used for formulated cold cream? a. pH b. Viscosity c. Spreadbility d. All of These 6. Aloevera Gel when applied on skin is helps to a. Fights skin-ageing b. Soothe sunburn c. Moisturize the skin d. All of the above 7. Sun Screen lotion is used to protect Skin from a. UV Rays b. Dust c. Cold d. None of these

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Course Category: Skill Enhancement Course (SEC)-1

120204 SEC Lab 3 Chemistry Lab Operations and Safety Measures

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	120204	SEC Lab 3 Chemistry Lab Operations and Safety Measures	2	60	--	50

Course Objectives:	1. To cultivate efficient working skills among the students to work in a chemistry laboratory. 2. To create a trained workforce which can responsibly learn imbibe and explore verticals on structured knowledge safely. 3. To make students aware of different chemicals and their properties being used in the chemistry laboratory. 4. To make aware about hazards in the laboratory.	
Course Outcomes:	After completion of the course student should able to 1. Design and implement safe working practices in chemistry laboratory. 2. Safely handle different glass apparatus. 3. Handle the chemicals and equipment safely and properly. 4. Design working protocols related to various methods and instruments in chemistry laboratory.	
Unit System	**Content**	**Incorporation of Pedagogies**
Experiments	1. Design an illustrative chart exhibiting creativity at transaction of Do's and Don'ts instructions for working in a chemistry laboratory. 2. Carry out Classification and labeling of the given set of chemicals based upon Globally Harmonized System. 3. Carry out preparation of the indicative MSDS (Material Safety Data Sheet) of given set of chemicals as per Standard MSDS format. 4. Design an illustrative chart exhibiting creativity at transaction of Common Safety Symbols along with its description. Associate appropriate safety symbol with each of the given set of chemicals. 5. Identify and enlist the Incompatible Chemicals from a given set of chemicals available in the laboratory. 6. Carry out a brief review of common pathways by which working Chemicals can enter the Body. 7. Classify the Hazard based on storage, handling, and disposal of chemicals. 8. Identification and describe handling protocols for Substances with Greater Hazardous Nature. 9. Carry out detailed investigations on procedural protocols for safe Disposal of Chemicals. 10. Carry out study on recommended Safety and Emergency Equipment essential for the safe practices in a Chemistry Laboratory. 11. Study the guidelines in the Event of a Chemical Accident or Spill. 12. Write detailed description on Fire Safety in the laboratory.	**Lab Reports:** Students prepare detailed lab reports on their findings. **Discussion Sessions**: Group discussions. **Group Projects**: Assign group projects on labeling and categorization of chemicals. **Class Debates**: Discuss the findings amongst the students.
References:	**Text books:** 1. Handbook for Laboratory Safety By Benjamin R. Sveinbjornsson and Sveinbjorn Gizurarson 2. CRC Handbook of Laboratory Safety By A. Keith Furr. 3. Laboratory Safety Handbook prepared by Fens Laboratory Safety Team. 4. Laboratory Safety by Richard Lumb Lisa Shephard Ivan Bastian Mark Fitz-Gerald 5. Laboratory Safety for Chemistry Students by Robert H Hill and David C Finster. **Web Resources:** 1. https://ucblueash.edu/content/dam/refresh/blueash-62/documents/academics/academic-departments/chemistry/LabSafetyRules.pdf 2. https://www.youtube.com/watch?v=VXB1HWnjQBA	

Model Questions:	**NA**

Distribution of Marks and the scheme of (SEC) Practical Examination is as follows:

Internal Assessment

- Active participation in activities 15 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 20 Marks
- Submission of duly certified practical record 10 Marks
- Internal examiner viva-voce 05 Marks

Total **50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Course Category: Major/Minor (Theory) - 2

120205 Fuels and Energy Balance

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	120205	Fuels and Energy Balance	2	30	2 Hrs	30+20=50

Course Objectives:	1. To understand the energy balance. 2. To understand the conventional and non-conventional energy sources. 3. To understand the sources of fuels 4. To understand the types of fuels.
Course Outcomes:	After completion of the course student should 1. Able to calculate the calorific value of fuel. 2. Able to differentiate between conventional and non-conventional energy sources. 3. Able to analyzed the coal by proximate and ultimate methods. 4. Able to understand the process of mining of fuels.

Unit System	Content	Work Load Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Energy Balance: Heat capacity, Cp, Cv, Molar heat capacity, Heat of reaction, formation, combustion, neutralization, Heat of solution, Hess's law of constant heat summation. Latent heat, latent heat of fusion, latent heat of vaporization, latent heat of sublimation. Problems based on heat of combustion, heat of Reaction and Heat of Formation.	8 Hours	8 Marks	1.Interactive Lectures: Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. 2. Hands-On Models: Use digital modeling software for virtual three-dimensional visualization. 3.Problem-Solving Sessions: Organize regular problem-solving sessions where students can apply theoretical knowledge to solve energy balance problems. 4.Flip-Class: Assign readings or video lectures as homework and use class time for interactive discussions and problem-solving
Unit II	Energy: General idea about conventional energy sources, and non-conventional Energy Sources–Solar energy, Space heating and water heating by solar energy, Production of electricity by solar energy, driving of vehicle by solar energy. Tidal power, Wind energy, Biomass energy, Geothermal Energy.	7 Hours	7 Marks	
Unit III	Solid fuels: Introduction, Classification of fuel on the basis of Occurrence, on the basis of physical state with examples. Coal: Types of coal, Coal formation, Coal analysis (proximate and ultimate), Destructive distillation of coal, Coal tar distillation, uses of coal tar products, Manufacturing of coal gas and water gas	8 Hours	8 Marks	
Unit IV	Liquid fuels: Introduction, Petroleum-Origin and classification, Fractional distillation of crude oil, Cracking, Mining of petroleum, natural gases, Uses of petroleum.	7 Hours	7 Marks	

References:	**Text Books:** 1. Non-conventional Energy Sources by G.D.Rai, Khanna Publishers 2. A Text Book of Physical Chemistry by P.L.Soni, Sultan Chand & Sons. 3. A Text Book of Engineering Chemistry by S. S. Dara, S. Chand and Co. 4. Engineering Chemistry by H.K. Chopra, A. Parmar, Alpha Science International Ltd. 5. Engineering Chemistry by Jain and Jain, Dhanpat Rai publishing Co. 6. Non-Conventional Energy Sources by N.K. Bansal, Vikas Publishing House. **Web Resources:** 1. https://nptel.ac.in/courses/103105110 2. https://archive.nptel.ac.in/content/storage2/courses/103105110/m1l1.pdf 3. http://www.ignou.ac.in/upload/unit-3.pdf
Model Questions:	**Short Type** 1. Discuss heat capacity with suitable example. 2. Give an account of Latent Heat. 3. Discuss various non-conventional energy sources. 4. Give an account of tidal power. 5. Give the uses of solar energy. 6. Give the classification of fuel on the basis of occurrence with suitable examples. 7. Give an account of types of coal. 8. Give the classification of petroleum. 9. Discuss the various uses of petroleum products.
	Long Type 1. Prove that Cp-Cv =R 2. Give the relationship between Cp and Cv. 3. What is Hess's law of constant summation? Discuss in detail. 4. Give an account of water heating by solar energy. 5. Explain the proximate analysis of coal. 6. Explain the process of destructive distillation of coal tar. 7. Explain the fractional distillation of crude oil. 8. Give an account of mining of petroleum.

MCQs

1. Amount of energy required to increase the temperature of one mole of system through 1^0 K is called as
   a) Molar heat capacity b) Heat of Reaction c) Latent Heat d) None of these
2. When matter changes from one state to another the energy change is called as
   a) Latent heat b) Heat of formation c) Heat of Solution d) Heat of Reaction
3. Which of the following is a source of non-conventional energy?
   a) Petrol b) Diesel c) Coal d) Sun
4. Which of the following is a source of conventional energy?
   a) Sun b) Wind c) Coal d) Geothermal
5. Which of the following is analyzed in Proximate analysis of coal?
   a) Nitrogen b) Moisture c) Total Carbon d) Sulphur
6. Which of the following is analyzed in Ultimate analysis of coal?
   a) Moisture b) ash c) Nitrogen d) None of these
7. Which of the following is a natural fuel?
   a) Petrol b) Diesel oil c) Wood d) Naphtha
8. Which of the following product is obtained from fractional distillation of crude oil?
   a) Petrol b) Naphtha c) Diesel oil d) All of these

Course Category: Major Lab-3

120206 Industrial Chemistry Lab 3

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	120206	Industrial Chemistry Lab 3	2	60	4 Hrs	25+25= 50

Course Objectives:	1. To understand the various systems of Units. 2. To Understand the stoichiometric equations and its applications. 3. To understand the various standardization methods.	
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for the interconversions of units. 2. Able to practical knowledge in professional life. 3. Able to analyzed coal sample. 4. Able to analyze liquid fuels.	
Unit System	**Content**	**Incorporation of Pedagogies**
Experiments	1. Determination of viscosity of lubricant oil by Redwood viscometer. 2. Determination of Aniline Point of Diesel. 3. Determination of moisture content in the given coal sample. 4. Determination of ash content in the given coal sample. 5. Determination of flash point of given fuel sample. 6. Determination of fire point of given fuel sample. 7. To determine Viscosity of petroleum sample by Redwood method. 8. Determination of cloud point of given petroleum sample. 9. Determination of pour point of given petroleum sample. 10. Determination of Melting point of wax.	**Lab Reports:** Students prepare detailed lab reports on their findings. **Discussion Sessions**: Group discussions. **Group Projects**: Assign group projects on stoichiometric methods. **Class Debates**: Discuss the findings amongst the students.
References:	**Text books:** 1. Practical Chemistry, by Ambrish Agarwal, Shivalal Agrawal and Co. 2. Laboratory Manual Chemistry by NCERT. 3. GCE Chemistry Practical Handbook Department of Science Faculty of Science and Technology National Institute of Education. 4. Text Book: Practical General Chemistry by Dr. Ahmad Al-Owais & Dr. Abdulaziz Al-Wassil. 5. Laboratory Manual for Engineering Chemistry Practical. 6. Engineering Chemistry Laboratory Manual, Maharaj Vijayaram Gajapathi Raj College of Engineering. 7. Understanding 0 level Chemistry Practical. 8. A Textbook on Experiments and Calculations in Engineering Chemistry By S.S Dara. S Chand Ltd. **Web Resources:** 1. https://www.youtube.com/watch?v=Yysmew-I1PI 2. https://www.youtube.com/watch?v=XtvSjXGqFVY	
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

• Active participation in activities	10 Marks
• Continuous Assessment Tests (CAT) (At least three tests) *	10 Marks
• Submission of duly certified practical record	05 Marks
Total	**25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

• Exercise 1	10 Marks
• Exercise 2	10 Marks
• Viva-Voce (external)	05 Marks
Total	**25 Marks**

Course Category: Generic/Open Elective-3

120207 Cleaning Products II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	120207	Cleaning Products II	2	30	2 Hrs	30+20=50

Course Objectives:	1. To understand the Various cleaning products. 2. To Understand the action of cleaning agents. 3. To identify various cleaning products as per its uses. 4. To develop sense of Entrepreneurship development
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for the preparation of cleaning products. 2. Able to prepare household cleaning products. 3. Able to start small scale business. 4. Able to apply basic concepts and innovative ideas during formulations

Unit System	Content	Work Load Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Cleaning agents: Introduction, History, Global and Indian Scenario. Market potential for cleaning products in India. Characteristics of Ideal Cleaning agent, Major raw materials having cleansing properties.	8 Hours	8 Marks	**1.Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts.
Unit II	Preparation, raw material, uses and properties of multipurpose cleaner, carpet shampoo, Toilet Cleaner, Handwash.	7 Hours	7 Marks	**2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization.
Unit III	Preparation, raw material, uses and properties of Wax Remover, Furniture Polish, Hair Gel and Hair oil	8 Hours	8 Marks	**3.Problem-Solving Sessions**: Organize regular problem-solving sessions
Unit IV	Preparation, raw material, uses and properties of Shoe Polish, Spot/stain Removers, Window and glass cleaner.	7 Hours	7 Marks	**4.Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions.

References:

Text Books:

1. Home Made Cleaners by Denise G. Dias Johnson Co. Extension Agent, FCS
2. Home Made Cleaning Products by Waste Virginia University.
3. Homemade Household Cleaners by Amanda Griffin and Randall A. Cantrell.
4. DIY Natural Cleaning by Kristin Marr.
5. Green Tok: The Ultimate Guide to Natural & Reduced Waste Cleaning
6. Cleaning Science Uttarakhand Open University.
7. Wax Polishes Manufacturing Hand Book by NPCS Board of Consultants and Engineer, Asia Pacific Business Press.

Web Resources:

1. Cleaners and Metal Polishes: https://www.slideshare.net/ei1234/formula-and-manufacture-of-polishes-floor-polish-oil-polish-metal-polish-furniture-polish-leather-polish-shoe-polish-automobile-polish-aluminum-polish-glass-polish

Model Questions:	**Short Type** 1. Discuss market potential of cleaning agents in India. 2. Discuss the characteristics of cleaning agents. 3. Give the major raw materials used in cleaning products. 4. Give the properties of carpet cleaner. 5. Give the raw materials used in carpet shampoo. 6. Give the properties of wax remover. 7. Discuss the raw materials used in furniture polish. 8. Give the properties of Multipurpose cleaner. 9. Give the raw materials used in stain remover.
	Long Type 1. Discuss the Global Trend about cleaning product. 2. Explain the method of preparation of Handwash. 3. How will you prepare multipurpose cleaner? Explain in detail. 4. Discuss the properties and applications of wax remover. 5. Explain the process of preparation of glass cleaner. 6. Explain the method of formulation of stain remover. 7. Discuss the raw material and characteristics of hair gel.
	MCQs 1. Which of the following is having cleansing properties? a. Lemon b. Baking Soda c. Vinegar d. All of these 2. Ideal cleaning agent should be a. Costly b. Toxic c. Non-Toxic d. low shelf life 3. Sodium lauryl sulfate is mainly used to prepare a. Metal polish b. Hand wash c. Air Freshener d. None of these 4. Which of the following is used in Wooden furniture Polish? a. Turpentine b. linseed oil c. Citrus thinner d. None of these 5. Flaxseed and Chia seed extract is used to prepare a. Metal Polish b. Floor Cleaner c. Herbal Hair Gel d. None of these 6. Iso Propyl alcohol is used as a reagent in a. Wax remover b. Tile Cleaner c. Drain Cleaner d. Mineral remover 7. Isopropyl alcohol, Mon ethanolamine and Glycol are the main reagents used in preparation of a. Shoe Polish b. Glass Cleaner c. Air freshener d. None of these

Course Category: Generic/Open Elective Theory-4

120208 Herbal Cosmetics II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	120208	Herbal Cosmetics II	2	30	2 Hrs	30+20=50

Course Objectives:	1. Students should aware about the present scenario of herbal cosmetics. 2. Students should aware about the market potential of the herbal and synthetic cosmetics 3. Students should understand the benefits of herbal cosmetics. 4. Should know the chemistry of Cosmetics.
Course Outcomes:	After completion of the course student should 1. Able to formulate various herbal cosmetics 2. Able to start their own small-scale production. 3. Able to differentiate synthetic and natural cosmetics. 4. Able to identify business opportunities.

Unit System	Content	Work Load Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Herbal Cosmetics:** Introduction, Product and its Applications, Industry outlook and trend, Market Potential and issues. Types of herbal cosmetics, Indian standards for Herbal Cosmetics.	8 Hours	8 Marks	**1.Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. **2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. **3.Problem-Solving Sessions**: Organize regular problem-solving sessions **4.Flip-Class:** Assign findings or video lectures as homework and use class time for interactive discussions.
Unit II	**Formulation of Face Wash:** Benefits of Herbal Face wash, Functions of face wash, desire properties. Formulation method, raw materials, Categories of therapeutic agents used in face wash, Additives used in Face Wash. Evaluation of Face Wash with respect to Colour, odour, consistency, spreadability, washability, foamability, grittiness.	7 Hours	7 Marks	
Unit III	**Formulation of Herbal Shampoo:** Benefits of Herbal Shampoo, Functions, desire properties. Formulation Method, raw materials, Evaluation with respect to pH, testing of wetting, foam stability, Dirt dispersion test, Conditioning performance evaluation	8 Hours	8 Marks	
Unit IV	**Formulation of Face Pack:** Benefits of Herbal Face Pack, Functions, desire properties. Formulation, raw materials Composition of Sunscreen lotion**,** Evaluation of formulated Face pack with respect to pH, Irritancy Test, Stability, Texture, smoothness.	7 Hours	7 Marks	

References:	**Text Books:** 1. Textbook of herbal cosmetics by Vaibhav Tripathi, Dinanath Jhade, Niraj Sharma, Rageeb Usman,S. Vikas & Co. Publishers. 2. Textbook of herbal cosmetics by M. Vimaladevi, CBS Publishers & Distributors. 3. Herbal Cosmetics Handbook by Himadri Panda, Asia Pacific Business Press. 4. Herbal Plants used in Cosmetics and Cosmeceuticals and their advantages over the Synthetic Counterparts by Charu Gupta and Dhan Prakash. 5. Text book of Cosmetic Formulations, by Sarah Adinda Puteri. **Web Resources:** **1.** Formulation of Cosmetics: https://www.slideshare.net/pharmmuthu/formulation-and-evaluation-of-cosmetic-products
Model Questions:	**Short Type** 1. Give the applications of Herbal Cosmetics. 2. Give the various types of Herbal Cosmetics 3. List down the benefits of Herbal Facewash. 4. Discuss the desire properties of herbal face wash. 5. How will you carry out evaluation of formulated face wash? Discuss any one test. 6. Give the benefits of Herbal Shampoo over the synthetic one. 7. What is foam stability test of shampoo? 8. Give the composition of Herbal Face Pack. 9. Discuss the desire properties of Face Pack.
	Long Type 1. Give an idea about Industrial Trend of Herbal Cosmetics in India. 2. Discuss various types of herbal Cosmetics. 3. Explain the formulation method of Face Pack. 4. Give an account of additives used in Face Pack. 5. How Formulated Herbal Shampoo be evaluated? Discuss in Detail. 6. Explain the formulation method of Herbal Shampoo. 7. Discuss the various raw materials used for preparation of Face Pack. 8. Discuss benefits of Herbal face pack over Synthetic one.

MCQs

1. Which of the following is used in preparation of herbal cosmetics?
   a. Aloe Vera b) Turmeric Powder c) Rosewater d) all of these

2. Herbal Face wash is used to
   a. Remove dead skin
   b. Keep skin fresh
   c. Keep skin healthy
   d. All of these

3. Good face wash should
   a. Spread easily on skin
   b. Have long drying period
   c. Have rough texture
   d. None of these

4. Which of the following is used as antioxidant in face wash?
   a. Propylene Glycol b. Fruits c. Vegetable d. Both b and c

5. Which of the following therapeutic agents used in face wash?
   a. Antimicrobial b. Anti-inflammatory c. Anti-acne d. all of these

6. Foaming agent used in Herbal Shampoo is
   a. Reetha b. Amla c. Hibiscus d. Bhringraj

7. Good Shampoo should have
   a. Good foam stability
   b. Less foam stability
   c. Both
   d. None of these

8. Good face pack should
   a. Supply necessary nutrients to the skin
   b. Penetrate deep down in skin
   c. Reduces wrinkles
   d. All of these

Course Category: Vocational Skill Course VSC-1

120209 Lab 4 Stoichiometry

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	120209	Lab 4 Stoichiometry	2	60	-	50

Course Objectives:	1. To understand the various standardization methods of reagents. 2. To Understand the stoichiometric equations and its applications. 3. To understand and able to standardized the solution.	
Course Outcomes:	After completion of the course student should 3. Able to apply basic knowledge for the standardization of solution. 4. Able to prepare various standard solutions. 5. Able to calibrate pipette and burette. 6. Able to prepare solution of desire concentration.	
Unit System	**Content**	**Incorporation of Pedagogies**
Experiments	1. Preparation of 1N solution NaOH. 2. Preparation of 1N solution HCL. 3. Preparation of 0.1N solution Oxalic Acid. 4. Preparation of $KMnO_4$ 1N solution. 5. Preparation of 0.1N solution Na_2CO_3. 6. Standardization of 1N solution NaOH. 7. Standardization of 1N solution HCL. 8. Standardization of 0.1N solution Oxalic Acid. 9. Standardization of $KMnO_4$ 1N solution. 10. Standardization of 0.1N solution Na_2CO_3 11. Preparation of 1N NaOH solution to 0.1 N NaOH solution. 12. Preparation of 1N Oxalic Acid solution to 0.1 N Oxalic Acid solution.	**Lab Reports:** Students prepare detailed lab reports on their findings. **Discussion Sessions**: Group discussions. **Group Projects**: Assign group projects on stoichiometric methods. **Class Debates**: Discuss the findings amongst the students.
References:	**Text books:** 1. Practical Chemistry by Ambrish Agarwal, Shivalal Agrawal and Co. 2. Laboratory Manual Chemistry by NCERT 3. GCE Chemistry Practical Handbook Department of Science Faculty of Science and Technology National Institute of Education. 4. Text Book: Practical General Chemistry by Dr. Ahmad Al-Owais & Dr. Abdulaziz Al-Wassil **Web Resources:** 1. https://www.chemicals.co.uk/blog/how-to-make-a-standard-solution 2. https://www.youtube.com/watch?v=iPYyRNjXkgY	
Model Questions:	**NA**	

Distribution of Marks and the scheme of (VSC) Practical Examination is as follows:

Internal Assessment

- Active participation in activities — 15 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * — 20 Marks
- Submission of duly certified practical record — 10 Marks
- Internal examiner viva-voce — 05 Marks

Total — **50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Course Category: Skill Enhancement Course (SEC-2) Lab 6
120210 Lab 5 Formulation of Cleaning Products

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	120210	Lab 5 Formulation of Cleaning Products	2	60	--	50

Course Objectives:	1. To understand the applications of Cleaning Agents. 2. To Understand the action of cleaning agents. 3. To understand the methods of formulation of various cleaning agents. 4. To develop sense of entrepreneurship.	
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for formulation of cleaning agent. 2. Able to identify various applications of Cleaners. 3. Able to start small scale business. 4. Able to apply innovative ideas in formulation.	
Unit System	**Content**	**Incorporation of Pedagogies**
Experiments	1. Formulation of Air Freshener. 2. Formulation of Floor Polish. 3. Formulation of Rust Remover. 4. Formulation of Tile Cleaner. 5. Formulation of Mineral deposit remover. 6. Formulation of Handwash. 7. Formulation of Wax Remover. 8. Formulation of Hair Gel. 9. Formulation of Shoe Polish. 10. Formulation of Stain Remover. 11. Formulation of Glass Cleaner.	**Lab Reports:** Students prepare detailed lab reports on their findings. **Discussion Sessions**: Group discussions. **Group Projects**: Assign group projects on formulation methods. **Class Debates**: Discuss the findings amongst the students.
References:	**Text books:** 1. Wax Polishes Manufacturing Hand Book by NPCS Board of Consultants and Engineer, Asia Pacific Business Press. 2. Home Made Cleaners by Denise G. Dias Johnson Co. Extension Agent, FCS 3. Home Made Cleaning Products by Waste Virginia University. 4. Homemade Household Cleaners by Amanda Griffin and Randall A. Cantrell. 5. DIY Natural Cleaning by Kristin Marr. 6. Green Tok: The Ultimate Guide to Natural & Reduced Waste Cleaning 7. Cleaning Science Uttarakhand Open University. **Web Resourses:** 1. https://www.youtube.com/watch?v=oC7BFcGRbAQ 2. https://www.youtube.com/watch?v=1FoE-P0T5Dw	
Model Questions:	**NA**	

Distribution of Marks and the scheme of (SEC) Practical Examination is as follows:

Internal Assessment

The 50 marks fragmentation as follows:

- Active participation in activities 15 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 20 Marks
- Submission of duly certified practical record 10 Marks
- Internal examiner viva-voce 05 Marks

Total **50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Degree of Bachelor of Science

Industrial Chemistry

Semester III and IV

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-27) Under NEP 2020 (As per Uniform NEP Scheme)

SYLLABUS

Contents

TLE Scheme for SECOND YEAR: SEMESTER – III (Level 5.0)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Industrial Chemistry	Major-T	120211	Mass Transfer Operations	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-T	120212	Unit Operations	2	2	30	9	20	6	50	20
Industrial Chemistry	IKS-T	120213	IKS in Industrial Chemistry	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-P	120214	Industrial Chemistry Lab 6	2	4	25	10	25	10	50	20
Industrial Chemistry	Minor-T	120215	Minor Industrial Chemistry 1	2	2	30	9	20	6	50	20
Industrial Chemistry	Minor-P	120216	Minor Industrial Chemistry Lab 7	2	4	25	10	25	10	50	20
Industrial Chemistry	GOEC-T	120217	Green Chemistry Approaches in Agro-Formulations	2	2	30	9	20	6	50	20
Industrial Chemistry	VSC-P	120218	Industrial Chemistry Lab -8	2	4	-	-	50	20	50	20
Industrial Chemistry	FP/CES	120219	Industrial Chemistry Lab 9 (FP / CES in Industrial Chemistry-I)	2	4	-	-	50	20	50	20
Industrial Chemistry	CC		Separate SOP will be released	2	4	-	-	50	20	50	20

Important: * VSC Should be Complementary to Major ** SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – IV (Level 5.0)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Industrial Chemistry	Major-T	120220	Unit Processes I	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-T	120221	Process Equipment's and Solid Waste Management	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-T*	120229*	Unit Processes II	2	2	30	9	20	6	50	20
Industrial Chemistry	Major-P	120222	Industrial Chemistry Lab 10	2	4	25	10	25	10	50	20
Industrial Chemistry	Minor-T	120223	Minor Industrial Chemistry 2	2	2	30	9	20	6	50	20
Industrial Chemistry	Minor-P	120224	Minor Industrial Chemistry Lab 11	2	4	25	10	25	10	50	20
Industrial Chemistry	GOEC-T	120225	Natural and Eco-friendly Dyes	2	2	30	9	20	6	50	20
Industrial Chemistry	VSC-P	120226	Industrial Chemistry Lab 12	2	4	-	-	50	20	50	20
Industrial Chemistry	SEC-P#	120227#	Industrial Chemistry Lab 13	2	4	-	-	50	20	50	20
Industrial Chemistry	FP/CES	120228	Industrial Chemistry Lab 14 (FP/CES in Industrial Chemistry-II)	2	4	-	-	50	20	50	20
Industrial Chemistry	CC		Separate SOP shall be consulted from University website	2	4	-	-	50	20	50	20

* To be implemented w.e.f. academic session 2026-27 # - Only applicable up to academic session 2025-26

Important: VSC Should be Complementary to Major and SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

Examination and Assessment Process:

i. The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

ii. Exit options are provided with Certificate, Diploma and Basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a Four Years Multidisciplinary Degree Programme. Students will receive a Bachelor's degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.

iii. For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019).

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table

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Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
A	Major	External & Internal	30	9	20	6	50	20	25	10	25	10	50	20
B	Minor		30	9	20	6	50	20	25	10	25	10	50	20
C	Generic/ Open Elective		30	9	20	6	50	20	--	--	--		--	--
D	VSC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	SEC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
E	AEC (Eng. & One MIL Composite)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	IKS (Generic)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	VEC	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
F	FP/CEP	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	Internship/ Apprenticeship		Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process is prescribed for Phase I and Phase II											
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e. 40 %) shall be based on the **best two out of three** in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule –

Sr. No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

***** The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.
2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.
3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.
4. Provided that the student shall be eligible to appear for examination if -
   a. He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
   b. He/she has prosecuted a regular course of study in a university department/college affiliated to the University.
   c. He/she has in the opinion of the Principal shown satisfactory progress in his/her studies.
5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.
6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

Course Category: Major (Theory) - 1

120211 Mass Transfer Operations

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	120211	**Mass Transfer Operations**	2	30	2 Hrs	30+20 = 50

Course Objectives:	1. To understand the basics of various Units Operations. 2. To Understand the applications of Units Operations. 3. To understand mechanism of various Units Operations.
Course Outcomes:	After completion of the course student should be 1. Able to apply basic knowledge for application of specific unit operation. 2. Able to apply specific equipment for particular unit operation. 3. Able to identify equipment for various unit operations. 4. Able to differentiate the applications of various unit operation equipment's.

Unit System	Content	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Distillation:** Introduction, Flash distillation, Differential distillation, Steam distillation, Azeotropic distillation, Continuous distillation with rectification and stripping, Plate column, Packed column.	8 Hours	8 Marks	**1.Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. **2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. **3.Problem-Solving Sessions:** Organize regular problem-solving sessions where students can apply theoretical knowledge to solve problems. **4.Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions and problem-solving.
Unit II	**Evaporation:** Introduction, Single and multiple effect evaporation, Short tube evaporator, Long tube evaporator, forced circulation evaporator, falling film evaporator, Climbing film evaporator (Upward flow evaporator), Agitated film evaporator, Evaporator capacity. Evaporator economy, Boiling point elevation.	7 Hours	7 Marks	
Unit III	**A) Extraction:** Introduction, Selection of solvent, Single stage and multistage extraction, Spray column, Packed column, Mixer settlers. **B) Leaching:** Introduction, Single stage leaching, Percolation tank, Counter current multiple contact (Shank's system), Continuous counter current decantation, Agitated vessels.	8 Hours	8 Marks	
Unit IV	**A) Crystallization:** Introduction Solubility, Saturation, Supersaturation, Nucleation, Crystal growth, Agitated tank crystallizer, Vacuum crystallizer, Swenson-Walker crystallizer. **B) Drying:** Introduction, Free moisture, Bound moisture, Moisture content on wet and dry basis, Equilibrium moisture content, Critical moisture content, Constant rate period, falling rate period, Drying Equipment's-Tray dryer, Drum dryer, Spray dryer, Rotary dryer, Rate of drying, Heat transfer in dryers, Drying of porous solids.	7 Hours	7 Marks	

References:	Text books: 1. Unit Operations-II by K.A. Gavhane, Nirali Prakashan. **Reference Books:** 1. Mass Transfer Operations By: Robert E. Treybal 2. Principles of Mass Transfer and Separation Processes By: B. K. Dutta 3. Separation Process Principles By: J. D. Seader, Ernest J. Henley, and D. Keith Roper 4. Mass Transfer: Theory and Practice By: Sujoy Kumar Saha 5. Transport Processes and Separation Process Principles By: Christie J. Geankoplis 6. Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer By: J.M. Coulson and J.F. Richardson 7. Unit Operations of Chemical Engineering by W.L. McCabe and J. C. Smith and P. Harriott, McGraw-Hill. 8. Unit Operations- G. G. Brown, CBS Publications. 9. Principles of Physical Chemistry- B.R.Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing Co. **Web Resources:** 1. NPTEL – Mass Transfer Operations I https://nptel.ac.in/courses/103103035 3. Learn ChemE – University of Colorado Boulder https://learncheme.com 4. Chemineers – Mass Transfer Operations Notes https://chemineers.com/mass-transfer/ 5. Research Gate – Mass Transfer Operation Publications https://www.researchgate.net
Model Questions:	**Short Type** 1. What is evaporation operation? 2. Define liquid-liquid extraction operation. 3. Discuss evaporators economy. 4. Discuss evaporators capacity. 5. Give the application of distillation operation. 6. Define leaching operation. 7. What is crystallization operation? 8. Give the applications of Drying operation.
	Long Type 1. Discuss construction and working of packed column for Distillation Operation. 2. Give an account of Continuous distillation with rectification and stripping. 3. Explain the construction and working of long tube evaporator 4. Give an account of single and multistage evaporation. 5. Discuss Counter current multiple contact the Shank system for leaching operation. 6. Describe the construction and working of Mixer settler for extraction operation. 7. Discuss the mechanism of crystallization. 8. Explain the construction and working of tray dryer with diagram. 9. Explain the construction and working of spray dryer with diagram.
	MCQs 1. Distillation operation is used to ----. a) Remove excess moisture b) thicken the product c) separate the liquid components d) None of these 2. Plate column is used in ------- operation. a) Distillation b) Evaporation c) Extraction d) leaching 3. The phase which is rich in solute is called as------Phase. a) Raffinate b) solid c) Extract d) liquid 4. Separation of solid component from liquid is called as----- a) Evaporation b) Leaching c) Drying d) Distillation 5. Shank system is used for ------- operation a) Distillation b) Drying c) Crystallization d) leaching 6. Separation of solid in the form of crystals from saturated solution is called as a) Drying b) Crystallization c) Extraction d) Distillation 7. Tray dryer is an example of-------dryer a) Direct b) Indirect c) Straight d) None of these 8. Spray dryer is an example of -------- dryer. a) Batch b) Continuous c) Straight d) None of these 9. Concentration of solute in its saturated solution at a given temperature is called as a) Extraction b) Solubility c) crystallization d) distillation

Course Category: Major (Theory) - 2

120212 Unit Operations

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	120212	**Unit Operations**	2	30	2 Hrs	30+20 = 50

Course Objectives:	1. To understand the basics of various size reduction equipment's. 2. To Understand the applications of various industrial screens. 3. To understand the basics of surface chemistry.
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for application of specific unit operation. 2. Able to identify the specific application of unit operation equipment 3. Able to identify the role of specific catalyst.

Unit System	Content	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Size Reduction:** Necessity of size reduction, Energy and power for size reduction, Crushing efficiency, Rittinger's law, Kick's law, Bond's law, Types of size reduction equipment's- Jaw crusher, Smooth roll crusher, Ball mill, Hammer mill.	8 Hours	8 Marks	**1. Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. **2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. **3. Problem-Solving Sessions**: Organize regular problem-solving sessions where students can apply theoretical knowledge to solve problems. **4. Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions and problem-solving.
Unit II	**Mechanical Separation:** Screening-Types of screening equipment's, Grizzlies screens, Trammel's screens, Ideal and actual screens, Capacity and effectiveness of screens. Filtration-Types of filtration, Constant pressure filtration, Constant rate filtration, Filter media, filter cake, Pressure filters, Plate and frame filter press, Rotary drum filter, Centrifugal filtration.	7 Hours	7 Marks	
Unit III	**Mixing and Agitation:** Mixing of liquid with liquid, mixing of gases with liquids, mixing of solids with liquids, Impellers, Propellers, Turbines, Paddles, Flow pattern in agitated vessels, Unbaffled tanks, Prevention of swirling and vortex formation, Baffling, Banbury mixer, Pug mill, Ribbon blenders, Tumbling mixer, Double arm kneader	8 Hours	8 Marks	
Unit IV	**A) Surface Chemistry:** Adsorption, Mechanism of adsorption, Types of adsorption, Adsorption isotherms, - Langmuir, BET and Freundlich isotherm, Factors affecting adsorption, Applications of adsorption, Sols and their preparations, Coagulation, Emulsions, Gels, Micelles, Surfactants. **B) Catalysis:** Introduction, Types of Catalysis-Homogeneous and heterogeneous, Mechanism, Characteristics of catalysts, Catalyst deactivation, Autocatalysis, Negative catalysis, Activation energy, Enzyme catalysis.	7 Hours	7 Marks	

References:	**Text books:** 1 Catalysis: Heterogeneous and Homogeneous- B. Delmon and G.Jannes, Elsevier Science Publisher. 1. Catalysis Science and Technology- J. R. Anderson, Springer-Verlag. 2. Surface Chemistry- J.J.Bikermann, Academic Press. 3. Principles of Physical Chemistry- B.R.Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing Co. 4. Unit Operations-II by K.A. Gavhane, Nirali Prakashan. **Web Resources** 1. NPTEL – Chemical Technology: Unit Processes and Operations https://nptel.ac.in/courses/103107125 2. AKTU (Dr. A.P.J. Abdul Kalam Technical University) – Syllabus for Chemical Engineering https://aktu.ac.in/syllabus.html 3. GTU (Gujarat Technological University) – Chemical Engineering Syllabus https://syllabus.gtu.ac.in 4. JNTU (Jawaharlal Nehru Technological University) – B.Tech Chemical Engineering Syllabus https://jntuh.ac.in 5. Anna University – Department of Chemical Engineering Syllabi https://www.annauniv.edu/academic_courses.html
	Short Type 1. Define size reduction. 2. State Kick's law. 3. Give an account of capacity of screens. 4. Define adsorption. 5. What is emulsion? 6. Define catalyst. 7. What is homogeneous catalyst? **8.** What is heterogeneous catalyst?
	Long Type 1. State and explain Rittenzer's law. 2. Give the construction and working of Jaw crusher with diagram. 3. Discuss construction and working of Trammel's screens with diagram. 4. Discuss various Filter media. 5. Explain the construction and working of Ribbon blenders with diagram. 6. Give an account of Mixing of solids with liquids. 7. Discuss Prevention of swirling and vortex formation. 8. Discuss the various factors affecting adsorption 9. Discuss i) Autocatalysis ii) Negative catalysis

Model Questions:	**MCQs** 1. What are the size reduction laws? a) Rittinger's Law b) Kick's Law c) Bond's Law d) all of these 2. Which mechanism is utilized when particle concussion by a single rigid force? a) Impact b) Compression c) Shear d) Tear 3. What is the primary method of filtration? a) Straining b) Sedimentation c) Centrifuge d) Diffusion 4. Which of the following is a pressure filter? a) Sand filter b) Rotary drum filter c) Plate and flame filter d) Leaf filter 5. What is the principle of mixing? a) Shear force b) Perpendicular force c) Gravitational force d) Centrifugal force 6. Which of the following type of paddle agitators are most commonly used? a) Two Bladed b) Three Bladed c) Four Bladed d) Two bladed and four bladed 7. An emulsifier is a substance which a) Stabilizes the emulsion b) coagulates the emulsion c) causes homogenesis of emulsion d) none of these 8. Which one of the following is not a catalysis category? a) Homogeneous b) Heterogeneous c) Artificial d) Enzymatic 9. Catalyst which are in same phase or state of reactant are called as ------- catalyst a) negative b) homogeneous c) heterogeneous d) none of these

Course Category: **Major (Theory)**

120213 Indian Knowledge System in Industrial Chemistry

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	120213	Indian Knowledge System in Industrial Chemistry	2	30	2 Hrs.	30+20=50

Course Objectives:	To help the students to bridge the gap between ancient Indian chemical knowledge and modern scientific inquiry, providing them a holistic understanding of the subject.
Course Outcomes:	Upon completion of this course, students will be able to: 1. Explain the importance and scope of IKS in Industrial chemistry. 2. Describe the knowledge about the Contributions of ancient Indian chemists. 3. Analyze Vedic metallurgical techniques and their impact on material sciences. 4. Explore the chemistry behind natural dyes and pigments used in historical contexts. 5. Describe different chemical processes used in ancient chemistry. 6. Rationalize the knowledge of plant used in Ayurveda and its chemical composition. 7. Compare various apparatus and different methods used in ancient and modern chemistry. 8. Evaluate the relevance of ancient chemical knowledge in contemporary scientific research.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation Pedagogies
Unit I	**Introduction to Indian Knowledge System and Chemistry** Concept of Indian Knowledge System (IKS): Meaning, significance, and relevance in modern science History of Chemistry in India: Contributions of ancient Indian chemists (e.g., Nagarjuna, Charaka, Sushruta, Rasashastra scholars) Traditional Indian Alchemy and Metallurgy: Processing of metals, mercury purification, and Ayurvedic applications. Role of IKS in Modern Industrial Chemistry: Integration with contemporary chemical practices	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts.
Unit II	**Traditional Indian Chemical Technologies:** Ancient Indian Metallurgy: Production of iron, steel (Wootz steel), copper, and zinc extraction. Traditional Indian Dyes and Pigments: Indigo dye, natural colorants, and their industrial applications. Soap and Detergents in Ancient India: Traditional formulations and their modern industrial relevance Ceramics and Glassmaking: Early glass production techniques and their industrial evolution.	7 Hrs	7 Marks	

Unit III	**Indian Contributions to Medicinal and Organic Chemistry** Ayurvedic Chemistry (Rasashastra): Classical formulations, Bhasma preparation, and their scientific validation. Fermentation Technology in India: Indigenous techniques for alcohol, vinegar, and organic acids production. Essential Oils and Perfumery: Distillation techniques used in ancient India for perfumes and therapeutic oils. Herbal-Based Industrial Chemistry: Use of plant-based chemicals in pharmaceuticals and cosmetics.	8 Hrs	8 Marks	**Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit IV	**Sustainability and Future Prospects of IKS in Industry** Eco-Friendly Chemical Practices in Ancient India: Sustainable chemical production and green chemistry concepts. Biodegradable Materials from Traditional Knowledge: Natural polymers, bioplastics, and their industrial scope. Role of IKS in Modern Industrial R&D: Integration of traditional knowledge with cutting-edge technology Case Studies and Current Research: Patents, innovations, and startups based on IKS principles in chemistry	7 Hrs	7 Marks	

References:	1. Indian Knowledge Systems: Concepts and Applications – Kapil Kapoor (Editor) 2. History of Science, Philosophy and Culture in Indian Civilization: Chemistry and Chemical Techniques in India – D.P. Chattopadhyaya & B.V. Subbarayappa 3. Science and Technology in Ancient India – Debi prasad Chattopadhyaya 4. A Concise History of Science in India – D.M. Bose, S.N. Sen, B.V. Subbarayappa 5. Traditional Indian Metallurgy – R. Balasubramaniam 6. Alchemy and Chemistry in the History of India – P. Ray 7. Ayurveda and the Mind – David Frawley 8. Rasaratna Samuccaya – Ancient Sanskrit text (translated versions available) 9. Rasendra Chudamani – Siddha Nagarjuna 10. The Chemistry of Ayurveda – Vaidya Bhagwan Dash 11. Vedic Science and Technology – Dr. H.S. Prakash 12. Materials and Manufacturing: A Historical Perspective from Indian Context – R. Balasubramaniam 13. Indian Alchemy: Its Origin and Development – Surendra Nath Dasgupta. **Web resources:** 1. Indian Knowledge Systems Division, Ministry of Education (GoI) https://iksindia.org 2. CSIR – Traditional Knowledge Digital Library (TKDL) https://www.csir.res.in/tkdl 3. IGNCA – Indira Gandhi National Centre for the Arts https://ignca.gov.in 4. Infinity Foundation India https://infinityfoundation.com 5. Indian National Science Academy (INSA) – History of Science https://insaindia.res.in 6. National Institute of Science Communication and Policy Research (NIScPR) https://www.niscpr.res.in

	Short Type (At least 8) 1. What are Indigenous Knowledge Systems (IKS) in the context of Industrial Chemistry? 2. Name one indigenous method of natural dye extraction and its industrial application. 3. What are some examples of bio-based materials derived from indigenous knowledge? 4. What role does IKS play in sustainable and eco-friendly chemical processes? 5. What are some challenges in integrating IKS with modern industrial chemical processes? 6. How has indigenous metallurgy contributed to modern industrial material science? 7. How have traditional fermentation techniques contributed to modern industrial processes? 8. How does IKS influence the production of herbal medicines and pharmaceuticals?
	Long Type (At least 4) 1. How do traditional soap-making methods compare to modern industrial soap production? 2. How can IKS contribute to green chemistry and sustainable industrial practices? 3. Discuss the significance of Indigenous Knowledge Systems (IKS) in Industrial Chemistry and how traditional practices have influenced modern industrial processes. 4. Explain the role of indigenous fermentation techniques in industries such as food processing, pharmaceuticals, and bioethanol production 5. Describe the contribution of IKS to herbal medicine production and its impact on the pharmaceutical industry. 6. Evaluate the role of indigenous metallurgy in industrial chemistry, particularly in the development of metal extraction and processing techniques. 7. How can IKS contribute to green chemistry principles in industrial applications? Provide examples of environmentally friendly practices inspired by traditional knowledge.

Model Questions:	**Multiple Choice Questions (MCQ): (At least 8)** 1. What does Indigenous Knowledge Systems (IKS) refer to in Industrial Chemistry? a) Modern chemical engineering techniques b) Traditional knowledge and practices used in chemical processes c) Only herbal medicine production d) Laboratory-based synthetic chemistry 2. Which of the following industries has been influenced by indigenous fermentation techniques? a) Textile industry b) Food and beverage industry c) Mining industry d) Electronics industry 3. Which natural product is commonly used in indigenous dyeing techniques? a) Indigo from plants b) Synthetic aniline dye c) Titanium dioxide d) Sulfuric acid 4. What is a key benefit of incorporating IKS into modern industrial chemical practices? a) Increased use of synthetic chemicals b) Promotion of eco-friendly and sustainable methods c) Higher dependence on fossil fuels d) Elimination of traditional practices 5. Which traditional process is widely used in indigenous soap-making? a) Saponification using animal fat and plant ashes b) Chemical reaction of sodium hydroxide with ethanol c) High-pressure polymerization d) Electrochemical oxidation 6. Which of the following indigenous techniques has contributed to metallurgy? a) Smelting of iron ore using charcoal b) Electroplating of metals c) Crude oil refining d) Synthetic polymer production 7. Which plant-based material is commonly used in indigenous bioplastic production? a) Cassava starch b) Polyethylene c) PVC d) Teflon 8. How can IKS contribute to green chemistry? a) By promoting biodegradable and renewable resources b) By increasing chemical waste c) By using more fossil fuels d) By relying solely on synthetic materials

Course Category: **Major Lab**

120214 Industrial Chemistry Lab 6

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	120214	Industrial Chemistry Lab 6	2	60	4 h	25+25= 50

Course Objectives:	1. To develop a strong conceptual understanding of fundamental principles in Industrial Chemistry through hands-on experimental work. 2. To enhance analytical and problem-solving skills by applying theoretical knowledge to laboratory-based tasks, including synthesis, analysis, titration etc.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Apply basic knowledge to select the proper distillation method for separation of liquid components from their mixture 2. Perform distillation operation with correct way. 3. Handle rotary evaporator in a scientific way for obtaining the correct result. 4. Apply the basic knowledge to choose the proper solvent for extraction operation. 5. Understand the effect of catalyst during the course of reaction.

Unit System	Contents	Incorporation of Pedagogies
Experiments	1. Simple distillation of salty water. 2. Fractional distillation of alcohol-water mixture. 3. Steam distillation of essential oil. 4. Industrial evaporation simulation using Rotary Evaporator. 5. Solvent Extraction of caffeine from tea leaves. 6. Liquid-liquid extraction of iodine from aqueous solution. 7. Extraction of oil from groundnut seeds. 8. Crystallization of benzoic by using water as a solvent. 9. Crystallization of benzoic acid using water-alcohol mixture as a solvent. 10. Effect of catalyst on reaction between sodium thiosulphate and hydrochloric acid. 11. Decomposition of hydrogen peroxide using manganese dioxide (MnO_2) as a catalyst. 12. Adsorption of acetic acid on charcoal.	• **Experiential Learning:** Hands-on experimentation using distillation assembly and rotary evaporator for distillation and evaporation operation respectively. • **Inquiry-Based Learning:** Students can foster critical thinking regarding various mass transfer operations and their industrial applications. • **Collaborative Learning:** Group-based distillation and extraction experiments encourage teamwork and peer learning. Discussions on effect of catalyst and catalytic activity enhance conceptual clarity and knowledge retention. • **Any other innovative pedagogy as applicable.**
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

***Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations**

Section 2: External Assessment

- Exercise 1 10 Marks
- Exercise 2 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category: **Minor (Theory)**

120215 Minor Industrial Chemistry-1

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5	III	120215	Minor Industrial Chemistry-1	2	30	2 Hrs	30+20=50

Course Objectives:	1. To understand the basics of various Units Operations. 2. To Understand the applications of Units Operations. 3. To understand mechanism of various Units Operations.
Course Outcomes:	After completion of the course student should 1. Able to apply basic knowledge for application of specific unit operation. 2. Able to apply specific equipment for particular unit operation. 3. Able to identify equipment for various unit operations. 4. Able to differentiate the applications of various unit operation equipment's.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I	**General Idea about Mass Transfer Operations:** Introduction to mass transfer operation, definition, role of mass transfer in chemical, pharmaceutical, petroleum and food industries and environmental engineering with respect to air and water purification.	7 Hrs	7 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts.
Unit-II	**Distillation:** Introduction, Flash distillation, Differential distillation, Steam distillation, plate column **Evaporation:** Introduction, Single and multiple effect evaporation, Evaporator capacity. Evaporator economy, long tube evaporator	8 Hrs	8 Marks	
Unit-III	**Size Reduction:** Necessity of size reduction, Energy and power for size reduction, Crushing efficiency, Rittinger's law, Kick's law, Bond's law, Types of size reduction equipment's- Jaw crusher, Smooth roll crusher, Ball mill, Hammer mill.	7 Hrs	7 Marks	
Unit-IV	**Mechanical Separation:** Screening-Types of screening equipment's, Grizzlies screens, Trammel's screens, Ideal and actual screens, Capacity and effectiveness of screens. Filtration-Types of filtration, Constant pressure filtration, Constant rate filtration, Filter media, filter cake, Pressure filters, Plate and frame filter press, Rotary drum filter, Centrifugal filtration.	8 Hrs	8 Marks	

References:	**Text books:** 1. Mass Transfer Operations by Robert E. Treybal 2. Separation Process Principles by J. D. Seader, Ernest J. Henley, and D. Keith Roper 3. Principles of Mass Transfer and Separation Processes by Binay K. Dutta 4. Transport Processes and Separation Process Principles by Christie J. Geankoplis 5. Coulson and Richardson's Chemical Engineering Volume 2: Particle Technology and Separation Processes by J.F. Richardson and J.H. Harker 6. Mass Transfer: Theory and Practice by A. P. Sinha 7. Diffusion: Mass Transfer in Fluid Systems by E. L. Cussler 8. Chemical Engineering: Volume 1 – Fluid Flow, Heat Transfer and Mass Transfer by J.M. Coulson and J.F. Richardson 9. Fundamentals of Momentum, Heat, and Mass Transfer by James R. Welty et al. 10. Mass Transfer and Separation Processes by Kaustubha Mohanty and M. M. Mishra. 11. Unit Operations of Chemical Engineering by W.L. McCabe and J. C. Smith and P. Harriott, McGraw-Hill. 12. Unit Operations-II by K.A. Gavhane, Nirali Prakashan **Web Resources** 1. https://ocw.mit.edu/courses/chemical-engineering/10-50-analysis-of-transport-phenomena- fall-2004/ 2. https://www.learncheme.com/Mass-Transfer 3. https://www.engineeringtoolbox.com/mass-transfer-d_196.html 4. https://nptel.ac.in/courses/103103035 5. https://www.cheresources.com/mass-transfer/

	Short Type 1. What is evaporation operation? 2. Define distillation operation. 3. Define evaporators economy. 4. What is evaporators capacity? 5. Give the application of distillation operation. 6. Define size reduction. 7. State Kick's law. 8. Give an account of capacity of screens.
	Long Type 1. Discuss construction and working of packed column for Distillation Operation. 2. Give an account of Continuous distillation with rectification and stripping. 3. Explain the construction and working of long tube evaporator 4. Give an account of single and multistage evaporation. 5. State and explain Rittenzer's law. 6. Give the construction and working of Jaw crusher with diagram. 7. Discuss construction and working of Trammel's screens with diagram. 8. Discuss various Filter media. 9. Explain the construction and working of Ribbon blenders with diagram. 10. Give an account of Mixing of solids with liquids.

Model Questions:	**MCQs** 1. Which of the following is used for size reduction of fibrous materials? a. Ball mill b. Hammer mill c. Cutter mill d. Fluid energy mill 2. In size reduction, the energy required per unit mass is inversely proportional to the size of the product according to: a. Kick's law b. Rittinger's law c. Bond's law d. Newton's law 3. Which of the following equipment is most suitable for fine grinding? a. Jaw crusher b. Ball mill c. Gyratory crusher d. Roll crusher 4. The term 'comminution' refers to: a. Mixing of particles b. Increase in particle size c. Size reduction of solids d. Separation of particles 5. Which one of the following is not a method of size reduction? a. Cutting b. Compression c. Impact d. Adsorption 6. In simple distillation, the component with the _____boiling point vaporizes first. a. Highest b. Lowest c. Same d. Average 7. Azeotropic distillation is used when: a. Components have identical boiling points b. Components form an azeotrope c. Components have very high relative volatility d. The feed is a solid-liquid mixture 8. The primary objective of an evaporator is to: a. Separate solids from liquids b. Increase the concentration of a solution c. Reduce particle size d. Increase the boiling point 9. In multiple-effect evaporators, steam economy increases by: a. Using more feed b. Increasing the pressure in all effects c. Using the vapor from one effect to heat the next d. Using vacuum in the first effect only 10. Which of the following evaporators is best suited for heat-sensitive materials? a. Long tube vertical evaporator b. Forced circulation evaporator c. Falling film evaporator d. Short tube evaporator

Course Category: **Minor Lab**

120216 Industrial Chemistry Lab 7

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	120216	Industrial Chemistry Lab 7	2	60	4 h	25+25= 50

Course Objectives:	1. To develop a strong conceptual understanding of fundamental principles in Industrial Chemistry through hands-on experimental work. 2. To enhance analytical and problem-solving skills by applying theoretical knowledge to laboratory-based tasks, including synthesis, analysis, titration etc.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Apply basic knowledge to select the proper distillation method for separation of liquid components from their mixture 2. Perform distillation operation with correct way. 3. Handle rotary evaporator in a scientific way for obtaining the correct result. 4. Apply the basic knowledge to choose the proper mechanical separator for separation operation.

Unit System	Contents	Incorporation of Pedagogies
Experiments	1. To break an azeotrope using a third component (entrainer) Azeotropic Distillation. 2. To separate a binary mixture of ethanol-water 3. Simple distillation of salty water. 4. Fractional distillation of alcohol-water mixture. 5. Steam distillation of essential oil. 6. Industrial evaporation simulation using Rotary Evaporator. 7. Determination of Particle Size Distribution Using Sieve Analysis. 8. To study the rate of filtration and factors affecting it. 9. To study the settling characteristics of particles in a fluid. 10. To Study the effect of Surface Area on Evaporation. 11. To study the effect of solute (e.g., salt) on boiling point during evaporation. 12. To determine the rate of evaporation of water under ambient conditions.	• **Experiential Learning:** Hands-on experimentation using distillation assembly and rotary evaporator for distillation and evaporation operation respectively. • **Inquiry-Based Learning:** Students can foster critical thinking regarding various mass transfer operations and their industrial applications. • **Collaborative Learning:** Group-based distillation and extraction experiments encourage teamwork and peer learning. Discussions on effect of catalyst and catalytic activity enhance conceptual clarity and knowledge retention. • **Technology-Enhanced Learning:** Digital tools, including simulation software, digital thermometers, improve precision in data collection and analysis. Virtual simulations supplement experimental learning, providing additional insights into complex concepts. • **Any other innovative pedagogy as applicable.**

References	1. Engineering Chemistry lab manual by Dr. N. Rama Jyothi, Shine book publishing. 2. Practical Engineering Chemistry by Archana Thakur. 3. Engineering Chemistry Practical Book by Dr. Preeti Jain, Dr. S.L. Garg, Variety Books Publishers Distributers 4. Practical Industrial Chemistry by Zena N siddiqqui. 5. A Textbook on Experiments and Calculations in Engineering Chemistry By S.S Dara. S Chand Ltd. **Web Resources** 1. https://ocw.mit.edu/courses/chemical-engineering/10-50-analysis-of-transport-phenomena-fall-2004/ 2. https://www.learncheme.com/Mass-Transfer 3. https://www.engineeringtoolbox.com/mass-transfer-d_196.html 4. https://nptel.ac.in/courses/103103035 5. https://www.cheresources.com/mass-transfer/
Model Questions:	**NA**

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

***Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations**

Section 2: External Assessment

- Exercise 1 10 Marks
- Exercise 2 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category: **GE/OE-3**

120217 Green Chemistry Approaches in Agro- Formulations

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	**III**	**120217**	**Green Chemistry Approaches in Agro-Formulations**	2	30	2 Hrs	30+20 =50

Course Objectives:	1. This course aims to understand the fundamental principles of green chemistry and their relevance in sustainable agriculture. 2. Analyze the chemical composition and functionality of eco-friendly fertilizers and pesticides. 3. Evaluate the environmental, economic, and safety aspects of agrochemical formulations. 4. Design innovative, scalable, and sustainable agrochemical solutions using interdisciplinary knowledge.
Course Outcomes:	By the end of this course, the students will be able to: 1. Explain the need for environmentally friendly agrochemical practices and identify key concepts in green chemistry. 2. Assess the roles of organic and biological components in promoting plant growth and controlling pests without harming the environment. 3. Critically analyze the impact of green formulations on soil health, biodiversity, farmer health, and climate change. 4. Encouraged to develop prototypes or models that integrate green chemistry, industrial processes, and agricultural needs.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Fundamentals of Green Chemistry and Sustainable Agriculture:** Principles of green chemistry and atom economy Overview of conventional agrochemicals and their environmental impact Importance of green chemistry in agriculture Sustainable agriculture: concepts and practices Introduction to agro-formulations: types and significance	8 Hrs	8 Marks	**Teaching Methods:** **Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. Lectures & Guest Talks: Concept delivery and expert interaction **Problem-Based Learning (PBL):** Solve real-world challenges (e.g., replace synthetic pesticide with bio-formulation) **Field Visits:** Agrochemical industries, organic farms, or research centers **Assessment Strategy:** Quizzes and written exams (theory understanding) Lab reports and formulation design Group presentations on case studies Capstone project: "Design a Sustainable Agro-formulation" **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Any other innovative pedagogy as applicable.**
Unit II	**Green Chemistry in Fertilizer Formulations:** Environmentally benign raw materials: organic waste, bio-resources Preparation of eco-friendly fertilizers: compost, vermicompost, green manure Biofertilizers: nitrogen-fixers, phosphate-solubilizers, potassium-mobilizers Green chemistry techniques in nutrient release control Analytical evaluation: pH, nutrient content, organic carbon, microbial viability.	7 Hrs	7 Marks	
Unit III	**Green Chemistry in Pesticide Formulations:** Natural pesticide sources: plant-based (neem, garlic, chili), microbial (Bt, Trichoderma) Extraction and formulation of botanical pesticides Green solvents and eco-safe adjuvants: emulsifiers, stabilizers, carriers Biodegradable and nano-based pesticide formulations Efficacy testing and environmental impact assessment.	8 Hrs	8 Marks	

Unit IV	**Industrial, Environmental, and Regulatory Aspects:** Industrial scale-up of green agro-formulations Waste minimization, energy efficiency, and closed-loop systems Quality control, shelf-life, and packaging of green agrochemicals Case studies: successful green agrochemical initiatives and innovations	7 Hrs	7 Marks	
References:	1. Green Chemistry in Agriculture and Food Production by Vinay Kumar, Pardeep Singh. 2. Green Chemistry for Sustainable Agriculture by N. K. Roy, S. K. Das 3. Green Chemistry and Sustainable Agriculture by Sanjay K. Sharma 4. Agrochemicals Detection, Treatment and Remediation by Mahendra Rai, Leonardo F. Fraceto 5. Agrochemicals in Soil and Environment by A. K. Srivastava 6. Pesticide Chemistry and Toxicology by G. Anita Sherma 7. Nanotechnology in Agriculture and Agroecosystems by Aditya Kumar, M. P. Singh 8. Nano-Biopesticides Today and Future Perspectives by Opender Koul 9. Green Nanoparticles: The Future of Agriculture by Kamel A. Abd-Elsalam 10. Bio-Based Nanoemulsions for Agrochemical Delivery by Neeraj Kumar, Santosh Kumar 11. Sustainable Agrochemistry by Sílvio Vaz Jr. 12. Ecofriendly Pest Management for Food Security by Omkar 13. Green Chemistry: Theory and Practice by Paul T. Anastas and John C. Warner 14. Principles of Sustainable Soil Management in Agroecosystems by Rattan Lal, B.A. Stewart 15. Advances in Green Chemistry: Innovative Processes and Products by Sanjay K. Sharma **Web resources:** 1. https://www.mdpi.com/journal/agronomy/special_issues/Green_Chemistry_Agriculture 2. https://www.acs.org/content/acs/en/greenchemistry.html 3. https://www.york.ac.uk/green-chemistry/ 4. https://suschem.org/ 5. https://iupac.org/what-we-do/projects/green-chemistry/			
Model Questions	**Short Type (At least 6)** 1. Define Green Chemistry. 2. What are biofertilizers? 3. What are bio pesticides? 4. What is green solvent? 5. Give any three advantages of using green agro-formulations over conventional agrochemicals. 6. What is atom economy?			
	Long Type (At least 4) 1. Discuss the principles of green chemistry. 2. Define biofertilizer. Give two examples and explain their role in sustainable farming. 3. How does neem act as a natural pesticide? Mention its active compound. 4. What is atom economy and why is it important in agrochemical synthesis? 5. List any three advantages of using green agro-formulations over conventional agrochemicals. 6. Explain the role of compost and vermicompost in eco-friendly fertilizer formulations. 7. What are green solvents? Give two examples used in pesticide extraction. 8. Describe the importance of biodegradable carriers in green pesticide formulations. 9. What are microbial pesticides? Give one example and its mode of action. 10. Name any two green chemistry techniques used in controlling nutrient release in fertilizers.			
Model Questions:	**MCQ (At least 8)** 1. Which of the following is a key principle of green chemistry? a) Use of toxic solvents b) Waste prevention c) Atom splitting d) Use of heavy metals 2. Which compound is the active ingredient in neem-based pesticides? a) Curcumin b) Azadirachtin c) Allicin d) Capsaicin 3. Biofertilizers mainly help in: a) Killing insects b) Fixing atmospheric nitrogen c) Producing synthetic nutrients d) Enhancing pesticide action			

4. Which of the following is a microbial pesticide?
   a) Neem extract
   b) Trichoderma viride
   c) Urea
   d) Calcium nitrate

5. What is the main purpose of green chemistry in agro formulations?
   a) Enhance toxicity
   b) Reduce crop yield
   c) Minimize environmental impact
   d) Increase chemical resistance

6. Which is NOT a principle of green chemistry?
   a) Designing safer chemicals
   b) Maximizing waste
   c) Use of renewable feedstocks
   d) Designing for energy efficiency

7. What is the major advantage of vermicompost in green agriculture?
   a) It is synthetic
   b) It requires chemical additives
   c) It improves soil structure and fertility
   d) It repels insects

8. Which analytical technique is commonly used to detect pesticide residues?
   a) Titration
   b) GC-MS
   c) Filtration
   d) UV photolysis

9. Jeevamrut is primarily used as a:
   a) Chemical pesticide
   b) Growth hormone
   c) Liquid organic fertilizer
   d) Synthetic herbicide

10. The solvent considered most eco-friendly in green chemistry is:
    a) Chloroform
    b) Benzene
    c) Water
    d) Carbon tetrachloride

11. Why is atom economy important in green chemistry?
   a) It increases chemical waste
   b) It reduces energy usage
   c) It maximizes product yield with minimal waste
   d) It enhances toxicity

12. Panchagavya is a traditional organic formulation made using:
   a) Plant hormones
   b) Five cow-based products
   c) Chemical surfactants
   d) Microbial toxins

Vocational Skill Course VSC-2

120218 Industrial Chemistry Lab-8 (Mass Transfer Operation Skills)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	120218	Industrial Chemistry Lab-8 (Mass Transfer Operation Skills)	2	60	4 Hrs	50

Course Objectives	1. To understand the applications of various unit operation. 2. To Understand the separation methods. 3. To understand how the mass is transfer during unit operations.
Course Outcomes	After completion of the course student should 1. Able to apply basic knowledge in unit operation experiments. 2. Able to extract oil from oil seeds. 3. Able to carry out solvent extraction process.

Unit	Content	Incorporation of Pedagogies
Experiments	1. Distillation of tap water. 2. Refluxing of oil and NaOH solution 3. Filtration of mixture of solid and liquid. 4. Recrystallization of Benzoic acid. 5. Distillation of hexane and oil solution. 6. Extraction of oil from oil seed. 7. Extraction of chlorophyll from plant leaf. 8. Recrystallization of oxalic acid. 9. Preparation of thick Liquor/solution evaporation. 10. Separation of two miscible liquids by distillation. 11. Separation of solute by solvent extraction. 12. Separation of immiscible liquid by separating funnel.	**Lab Reports:** Students prepare detailed lab reports on their findings. **Discussion Sessions**: Group discussions. **Group Projects**: Assign group projects on stoichiometric methods. **Class Debates**: Discuss the findings amongst the students.
References	**Text books:** 1. Shivalal Practical Chemistry, Shivalal Agrawal and Co. 2. Laboratory Manual Chemistry by NCERT 3. GCE Chemistry Practical Handbook Department of Science Faculty of Science and Technology National Institute of Education. 4. Text Book: Practical General Chemistry By Dr. Ahmad Al-Owais & Dr. Abdulaziz Al-Wassil. 5. Laboratory Manual for Engineering Chemistry Practical. 6. Engineering Chemistry Laboratory Manual, Maharaj Vijayaram Gajapathi Raj College of Engineering. 7. Understanding 0 level Chemistry Practical 8. A Textbook on Experiments and Calculations in Engineering Chemistry By S.S Dara. S Chand Ltd. 9. Practical Lab Manual of Pharmaceutical Organic Chemistry – I by Dr. Shivendra Kumar Dwivedi, IP Innovative Publication Pvt. Ltd. **Web resources:** 1. https://ocw.mit.edu/courses/chemical-engineering/10-50-analysis-of-transport-phenomena-fall-2004/ 2. https://www.learncheme.com/Mass-Transfer 3. https://www.engineeringtoolbox.com/mass-transfer-d_196.html 4. https://nptel.ac.in/courses/103103035 5. https://www.cheresources.com/mass-transfer/	

Distribution of Marks and the scheme of (VSC) Practical Examination is as follows:

Section I: Continuous Internal Assessment

- Continuous Assessment Tests (CAT) (At least three tests) * 15 Marks
- Submission of duly certified practical record 10 Marks

Total 25 Marks

Section II: End Semester Examination (Internal only)

- Exercise 1 20 Marks
- Viva-Voce (internal) 05 Marks

Total 25 Marks

Total (Section I And II) 50 Marks

***Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations**

Course Category: **FP/CEP-I**

120219 Industrial Chemistry Lab- 9 (FP/ CEP in Industrial Chemistry - I)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	120219	Industrial Chemistry Lab- 9 (FP/ CEP in Industrial Chemistry - I)	2	60	--	50

Course Objectives:	The intended objectives are: • To develop an appreciation of rural culture, lifestyle and wisdom amongst students. • To learn about the status of various agricultural and development programmes. • To understand the causes of distress and poverty faced by vulnerable households and explore solutions for the same. • To apply classroom knowledge of courses to field realities and thereby improve the quality of learning.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Gain an understanding of rural life, Indian culture and ethos and social realities 2. Develop a sense of empathy and bonds of mutuality with the local community 3. Appreciate significant contributions of local communities to Indian society and Economy 4. Learn to value the local knowledge and wisdom of the community 5. Identify opportunities for contributing to community's socio-economic improvements

Guidelines/ SoP for FP/CEP

For understanding key principles of CE, forms of CE, operational guidelines and implementation strategy please refer https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf

As per NEP 2020, students of B Sc. II of Semester III and IV need to perform a Field Project (FP) for TWO (2) credits i.e. 50 Marks. The guidelines regarding the field project are as follows:

1) The total time allocation for the student to carry out field project is 60 hours.
2) Students should participate in field-based projects under the supervision of faculty.
3) Assignment of project topics to individual students or groups of students (max 4 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
4) For a SURVEY based project related questionnaire (15 or more questions) should be prepared.
5) The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
6) If the project is related to work that does not involve survey work, then the questionnaire part can be replaced accordingly (e.g. Sample collection/Data collection/ Experimental base etc.).
7) The student should compile all the relevant data and carry out its analysis.
8) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc.
9) The project report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.). Submit the project report with the Guide's signature to the department.
10) The oral /poster presentation for all the projects should be arranged in the department. To evaluate the project, examiner should be appointed by HoD.
11) The total project work including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

Some suggested forms of FP/ CEP are:

1. **Linking learning with community service:** For example, students of Industrial chemistry can conduct water and soil testing in local areas and share the results with the local community.
2. **Linking research with community knowledge:** Community-based Participatory Research (CBPR) approaches are gaining recognition in this regard. For example, students of Industrial chemistry can undertake research in partnership with the community on solid and liquid waste disposal.
3. **Knowledge sharing and knowledge mobilization:** These can take the forms of enumerations, surveys, awareness camps and campaigns, training, learning manuals/films, maps, study reports, public hearings, policy briefs, cleanliness and hygiene teachings, legal aid clinics, etc. For example, students can undertake a 'swachhta survekshana' and/or nutrition survey for mothers and children, and educate them about hygiene and nutrition.
4. **Social innovations by students:** The students can be encouraged to initiate learning projects with a social impact and supported by HEIs. Incubation of such social innovation projects by students can also have meaningful links to existing curriculum and courses.

A few suggested (not exclusive) areas which not only provide practical applications of chemistry concepts but also foster collaboration, education, and sustainable practices within the community. are:

1. Understanding the chemical footprints of household products such as toothpaste, haircare, facecare food products etc.
2. Enhance science literacy among school students through interactive chemistry demonstrations.
3. Managing organic waste to composting and improve soil health.
4. Explore the extraction and application of natural dyes as alternatives to synthetic dyes.
5. Identify and mitigate lead exposure risks in the community.
6. Implement a community-wide recycling initiative focusing on chemical waste and recyclable materials.
7. Introduce and demonstrate the principles of renewable energy sources, such as biofuels or solar energy.
8. Assess local air quality and raise awareness about pollution sources and mitigation strategies.
9. Educate community members on the safe use, storage, and disposal of household chemicals.
10. Assist local farmers in understanding soil nutrient content and composition to optimize crop production.
11. Evaluate local water sources for contaminants such as heavy metals, nitrates, and pH levels.

References	1. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 2. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program 3. https://www.immerse.education/study-tips/100-ideas-for-research-projects-in-chemistry/ 4. https://pubs.rsc.org/en/content/articlelanding/2021/rp/d0rp00374c 5. https://www.acs.org/education/student-communities/activities.html 6. https://www.nettercenter.upenn.edu/academically-based-community-service-chemistry- outreach
Model Questions:	**NA**

Distribution of Marks and the scheme of FP/CEP Examination is as follows:

- Students' performance 20 Marks
- Submission of duly certified FP/CEP report 20 Marks
- Presentation (PPT or Poster) 10 Marks

Total **50 Marks**

Course Category: **Major (Theory)**

120220 Unit Processes I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120220	Unit Processes I	2	30	2 Hrs	30+20=50

Course Objectives:	Students will familiarize about 1. The concept of unit processes and distinguish them from unit operations in chemical manufacturing. 2. Clear understanding of major unit processes such as nitration, sulfonation, halogenation, oxidation, reduction. 3. The mechanistic and kinetic aspects of these processes to understand how they influence product yield, selectivity, and safety. 4. Industrial applications of unit processes in agrochemical, pharmaceutical, and petrochemical sectors. 5. Analysis and raw material selection, reaction conditions, and catalysts involved in key unit processes. 6. Problem-solving skills by evaluating process design, scaling up reactions, and troubleshooting industrial chemical reactions. 7. Foundational knowledge for process intensification and greener alternatives in modern chemical industries.
Course Outcomes:	After successful completion of this course, students will be able to: 1. Explain the principles and mechanisms of various unit processes such as nitration, sulfonation, halogenation, oxidation, and reduction. 2. Differentiate between unit operations and unit processes and describe their roles in chemical industries. 3. Analyze process parameters (e.g., temperature, pressure, catalyst, reaction time) and their impact on product yield and selectivity. 4. Apply knowledge of unit processes to design and evaluate chemical reaction pathways for the synthesis of industrial products. 5. Assess the environmental, safety, and sustainability aspects associated with different unit processes. 6. Solve practical and industrial problems related to process optimization, scale-up, and troubleshooting of unit processes.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Nitration** – Introduction, nitrating agents, nitryl ion, nitration of i) Benzene to nitrobenzene and m- dinitrobenzene. ii) Chlorobenzene to *o* and *p*- nitro-chlorobenzenes. iii) Acetanilide to p- nitro-acetanilide. Continuous and batch nitration.	8 Hrs	8 Marks	**1.Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. **2. Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. **3.Problem-Solving Sessions**: Organize regular problem solving sessions where students can apply theoretical knowledge to solve problems.
Unit II	**Amination by Reduction –** Introduction, methods of reduction, Bechamp Reduction (Iron and Acid Reduction), sulphide reduction, alkali sulphite reduction, metal hydrides reduction, cathodic reduction. Chemical and physical factors affecting amination. Manufacturing of aniline, m- nitroaniline, p-aminophenol.	7 Hrs	7 Marks	
Unit III	**Alkylation:** Introduction, types of alkylation, alkylating agents, thermodynamics of alkylation, mechanism of alkylation. Manufacturing of alkylbenzene, ethylbenzene.	8 Hrs	8 Marks	

Unit IV	**Sulphonation:** Introduction, Applications of sulphonates, sulphonating agents, chemical and physical factors affecting sulphonation reaction. Sulphonation of benzene, sulphonation of naphthalein. Industrial equipments and techniques, Batch and Continuous sulphonation.	7 Hrs	7 Marks	**4.Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions and problem-solving. **Pedagogy as applicable.**

References:	1. Unit Processes in Organic Synthesis By P.H. Groggins 2. Organic Chemistry – A Mechanistic Approach By Carol Walter 3. Chemical Process Principles (Part I & II) By O.A. Hougen, K.M. Watson, R.A. Ragatz 4. Unit Processes and Organic Synthesis By D.V. Giridhar 5. Dryden's Outlines of Chemical Technology By M.Gopal Rao and M.Sittig 6. Shreve's Chemical Process Industries By George T. Austin 7. Industrial Organic Chemistry By Klaus Weissermel and Hans-Jurgen Arpe 8. Introduction to Chemical Engineering By Badger and Banchero 9. Chemical Reaction Engineering By Octave Levenspiel 10. Industrial Chemistry By B.K. Sharma 11. Textbook of Organic Chemistry By Arun Bahl and B.S. Bahl 12. Industrial Chemical Technology By G.N. Pandey 13. Unit Processes in Pharmaceutical Industry By R.G. Kale and R.P. Bakshi 14. Chemical Engineering – Volume 6 (Design) By R.K. Sinnott 15. Applied Chemistry – Industrial Chemistry By R. Gopalan, D. Venkappayya, S. Nagarajan **Web resources:** 1. https://www.orgsyn.org/ 2. https://www.organic-chemistry.org/ 3. https://www.unitoperation.com/ 4. https://archive.org/details/epdf.pub_unit-processes-in-organic-synthesis 5. https://www.mtu.edu/chemical/facilities/teaching/operations/ 6. https://chbe.illinois.edu/academics/undergraduate/unit-operations https://en.wikipedia.org/wiki/Unit_operation
Model Questions:	**Short Type (At least 8)** 1. What is a unit process? 2. Give an example of a unit process. 3. Name any two unit processes used in organic synthesis. 4. What is the purpose of sulfonation in industrial chemistry? 5. Which catalyst is commonly used in sulphonation? 6. What is alkylation? 7. Define nitration in terms of a unit process. 8. What are nitrating agent? 9. What is amination? 7. What is sulphonation.

	Long Type (At least 4) 1. Explain the manufacturing process of nitrobenzene with flow diagram. 2. Discuss nitrating agents with suitable examples. 3. Discuss the various physical and chemical factors affecting amination reaction. 4. Describe the Manufacturing of aniline with flow diagram 5. Discuss various alkylating agents. 6. Explain the process of manufacturing of alkyl benzene with flow diagram. 7. Discuss the various factors affecting sulphonation reaction. 8. Describe the sulphonation of benzene with flow diagram. 9. Discuss batch and continuous sulphonation.
	MCQs for Internal Assessment (At least 8) 1. Which of the following is a unit process? a) Distillation b) Filtration c) Nitration d) Crystallization 2. The sulfonating agent used in sulfonation of benzene is: a) Hydrochloric acid b) Sulfuric acid c) Acetic acid d) Nitric acid 3. Which of the following is NOT a unit process? a) Halogenation b) Reduction c) Evaporation d) Oxidation 4. In nitration, which acid is typically used along with nitric acid? a) Sulfuric acid b) Hydrochloric acid c) Phosphoric acid d) Acetic acid 5. Which unit process introduces a nitro group into an organic compound? a) Hydrolysis b) Nitration c) Oxidation d) Sulfonation 6. Which of the following unit processes is commonly used in dye manufacturing? a) Sublimation b) Nitration c) Osmosis d) Decantation 7. Which of the following is a nitrating agent? a) Nitric acid b) N_2O_5 c) N_2O_3 d) All of the above 8. Which of the following is a sulphonating agent? a. Sulphuric acid b. SO_3 c. SO_2 d. All of the above

Course Category: **Major (Theory)**

120221 Process Equipment's and Solid Waste Management

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120221	Process Equipment's and Solid Waste Management	2	30	2 Hrs	30+20=50

Course Objectives:	1. To impart knowledge of the design, operation, and selection of process equipment used in chemical and allied industries. 2. To enable students to analyze the mechanical and thermal aspects of process vessels, heat exchangers, and reactors. 3. To develop the ability to apply standards and codes in the design of safe and efficient process systems. 4. To provide an understanding of the sources, characteristics, and classification of solid waste. 5. To introduce technologies and methods for the collection, transportation, processing, and disposal of solid waste. 6. To promote sustainable practices through the principles of reduce, reuse, recycle, and recovery (4Rs) in waste management.
Course Outcomes:	After successful completion of the course, a student will be able to- 1. Understand the principles of design and operation of various process equipment. 2. Apply mechanical and thermal design concepts to evaluate equipment performance under various operating conditions. 3. Identify and categorize different types of solid waste based on their sources and composition. 4. Evaluate suitable collection, treatment, and disposal methods for effective solid waste management. 5. Design sustainable waste management strategies incorporating recycling, composting, and energy recovery principles.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**A) Thermometer –** Glass, bimetallic, pressure spring, resistance and radiation pyrometer. **B) Pressure –** Manometer, barometer, pressure gauge, diaphragm, Macleon and Pirani gauge.	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based**
Unit II	**Liquid level –** Direct and indirect liquid level, measurement, float type liquid level gauge, ultrasonic level gauge, and bell type liquid level gauge.	7 Hrs	7 Marks	
Unit III	**A) Corrosion-** Introduction, types of corrosion (galvanic, open air, underwater & underground). Mechanism of corrosion. Factors affecting corrosion. **a. Passivity –** Introduction, chemical and mechanical passivity, oxide film **b. theory of passivity.** **B) Methods adopted for preventing corrosion** (metal coating processes) i) Galvanizations of iron (ii) Electro plating (iii) Painting (iv) Plastic coating. Corrosion inhibitor. **C) Oil Paints and Varnishes** - Introduction,	8 Hrs	8 Marks	

Unit IV	**Industrial solid waste and Treatment processes** **A)** Introductions, types of solid wastes, methods of industrial solid waste treatment & disposal. i) Composting, ii) Sanitary Land-fills, iii) Thermal process (Incineration & pyrolysis) iv) Recycling & reuse. **B) Hazardous waste –** Types, radioactive waste, biomedical waste	7 Hrs	7 Marks	**Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative Pedagogy as applicable.**	

References:	1. Process Equipment Design By M.V. Joshi and V.V. Mahajani 2. Coulson & Richardson's Chemical Engineering – Vol. 6: Design By R.K. Sinnott 3. Process Heat Transfer By D.Q. Kern 4. Chemical Engineering Design By Gavin Towler and R.K. Sinnott 5. Mechanical Design of Process Systems By M.W. Kellogg Company 6. Solid Waste Management: Principles and Practice By Ramesha Chandrappa and Umesh Chandra 7. Integrated Solid Waste Management By George Tchobanoglous, Hilary Theisen, and Samuel Vigil 8. Environmental Engineering – Vol. 2: Solid Waste Processing and Disposal By H.S. Peavy, D.R. Rowe, and G. Tchobanoglous 9. Municipal Solid Waste Management By Sundara Rajan 10. Waste Management Practices: Municipal, Hazardous, and Industrial By John Pichtel **Web resources:** 1. https://encyclopedia.che.engin.umich.edu/ 2. https://richardturton.faculty.wvu.edu/publications/chemical-process-equipment-design 3. https://www.chemicalprocessing.com/ 4. https://swana.org/ 5. https://www.iswa.org/ 6. https://www.epa.gov/environmental-topics/land-waste-and-cleanup-topics
Model Questions:	**Short Type (At least 8)** 1. What is the use of barometer? 2. What is the function of a pressure vessel? 3. Which material is commonly used for constructing chemical reactors? 4. Name a common corrosion prevention method in process equipment. 5. What is composting? 6. What is the 4R principle in waste management? 7. Which gas is commonly produced in landfills? 8. What is the purpose of segregation in waste management?
	Long Type (At least 4) 1. Discuss construction and working of pressure spring thermometer. 2. Give an account of construction and working of barometer. 3. Give an account of Direct and indirect liquid level, measurement. 4. Explain underwater corrosion. 5. Give an account of passivity. 6. Discuss Galvanizations of iron for preventing corrosion. 7. Define solid waste. Classify the different types of solid waste and describe their sources. 8. Explain the various steps involved in an integrated solid waste management system. 9. Describe the process of composting. 10. Discuss the design and operation of sanitary landfills.

	MCQs for Internal Assessment (At least 8) 1. Which thermometer is based on the principle of thermal expansion of liquids? a) Bimetallic thermometer b) Mercury-in-glass thermometer c) Infrared thermometer d) Thermocouple 2. Which device is commonly used to measure high pressures in industrial processes? a) Manometer b) Bourdon tube gauge c) Thermometer d) Anemometer 3. Which instrument measures pressure by balancing it against a column of liquid? a) Pressure transducer b) Manometer

c) Bourdon gauge
d) Thermocouple

4. Which of the following is a type of corrosion?
a) Galvanic corrosion
b) Elastic deformation
c) Surface tension
d) Thermal fatigue

5. Which method is commonly used to prevent corrosion of underground pipelines?
a) Electroplating
b) Cathodic protection
c) Galvanization
d) Painting

6. Which of the following is NOT a method to prevent corrosion?
a) Coating with paint
b) Anodizing
c) Sand blasting
d) Electroplating

7. Passivity in metals refers to:
a) Increased reactivity with acids
b) Formation of a porous layer
c) Inactivity due to protective oxide layer
d) Loss of magnetic property

8. Which of the following is a common physical method for treating industrial solid waste?
a) Composting
b) Incineration
c) Screening
d) Anaerobic digestion

9. The process of burning industrial solid waste at high temperatures is called:
a) Composting
b) Landfilling
c) Incineration
d) Recycling

10. Which treatment method reduces the volume of industrial waste but may produce toxic gases?
a) Landfilling
b) Composting
c) Incineration
d) Flocculation

11. Which method is suitable for managing organic industrial solid waste?
a) Gasification
b) Composting
c) Electrolysis
d) Pyrolysis

Course Category: **Major (Theory)**

120229 Unit Processes II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120229	Unit Processes II	2	30	2 Hrs	30+20=50

Course Objectives:	Students will familiarize about 1. The concept of unit processes and distinguish them from unit operations in chemical manufacturing. 2. Clear understanding of major unit processes such as halogenation, oxidation, hydrogenation, esterification. 3. The mechanistic and kinetic aspects of these processes to understand how they influence product yield, selectivity, and safety. 4. Industrial applications of unit processes in agrochemical, pharmaceutical, and petrochemical sectors. 5. Analysis and raw material selection, reaction conditions, and catalysts involved in key unit processes. 6. Problem-solving skills by evaluating process design, scaling up reactions, and troubleshooting industrial chemical reactions. 7. Foundational knowledge for process intensification and greener alternatives in modern chemical industries.
Course Outcomes:	After successful completion of this course, students will be able to: 1. Explain the principles and mechanisms of various unit processes such as halogenation, oxidation, hydrogenation, esterification. 2. Differentiate between unit operations and unit processes and describe their roles in chemical industries. 3. Analyze process parameters (e.g., temperature, pressure, catalyst, reaction time) and their impact on product yield and selectivity. 4. Apply knowledge of unit processes to design and evaluate chemical reaction pathways for the synthesis of industrial products. 5. Assess the environmental, safety, and sustainability aspects associated with different unit processes. 6. Solve practical and industrial problems related to process optimization, scale-up, and troubleshooting of unit processes.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**A) Halogenation-** Introduction, halogenating agents, chlorination, iodination, fluorination. Nuclear and side chain aromatic halogenation. Manufacturing of chlorobenzene, Manufacturing of chloral, manufacturing of mono-chloro acetic acid.	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts.
Unit II	**Oxidation –** Introduction, oxidising agents, types of oxidative reactions, mechanism and kinetics of oxidation reaction. liquid and vapour phase oxidation. Manufacturing of benzoic acid, acetaldehyde and acetic acid.	7 Hrs	7 Marks	
Unit III	**A) Hydrogenation -** Introduction, various catalysts used for hydrogenation. Kinetics and thermodynamics of hydrogenation reaction. Manufacturing of methanol from carbon monoxide and hydrogen, hydrogenation of vegetable oil.	8 Hrs	8 Marks	

Unit IV	**Esterification -** Introduction, esterification of organic acids using unsaturated compounds. Catalytic esterification. Manufacturing of ethyl acetate, vinyl acetate, cellulose acetate.	7 Hrs	7 Marks	**Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative Pedagogy as applicable.**	
References:	1. Unit Processes in Organic Synthesis By P.H. Groggins 2. Organic Chemistry – A Mechanistic Approach By Carol Walter 3. Chemical Process Principles (Part I & II) By O.A. Hougen, K.M. Watson, R.A. Ragatz 4. Unit Processes and Organic Synthesis By D.V. Giridhar 5. Dryden's Outlines of Chemical Technology By M.Gopal Rao and M.Sittig 6. Shreve's Chemical Process Industries By George T. Austin 7. Industrial Organic Chemistry By Klaus Weissermel and Hans-Jurgen Arpe 8. Introduction to Chemical Engineering By Badger and Banchero 9. Chemical Reaction Engineering By Octave Levenspiel 10. Industrial Chemistry By B.K. Sharma 11. Textbook of Organic Chemistry By Arun Bahl and B.S. Bahl 12. Industrial Chemical Technology By G.N. Pandey 13. Unit Processes in Pharmaceutical Industry By R.G. Kale and R.P. Bakshi 14. Chemical Engineering – Volume 6 (Design) By R.K. Sinnott 15. Applied Chemistry – Industrial Chemistry By R. Gopalan, D. Venkappayya, S. Nagarajan **Web resources:** 1. https://www.orgsyn.org/ 2. https://www.organic-chemistry.org/ 3. https://www.unitoperation.com/ 4. https://archive.org/details/epdf.pub_unit-processes-in-organic-synthesis 5. https://www.mtu.edu/chemical/facilities/teaching/operations/ 6. https://chbe.illinois.edu/academics/undergraduate/unit-operations 7. https://en.wikipedia.org/wiki/Unit_operation				
Model Questions:	**Short Type (At least 8)** 1. What is a unit process? 2. Give an example of a unit process. 3. Name any two unit processes used in organic synthesis. 4. What is the purpose of esterification in industrial chemistry? 5. Which catalyst is commonly used in halogenation? 6. What is halogenation? 7. Define oxidation in terms of a unit process. 8. Give any two examples of oxidizing agent used in oxidation processes? 9. What is Hydrogenation?				
	Long Type (At least 4) 1. Explain the manufacturing process of chlorobenzene with flow diagram. 2. Discuss halogenating agents with suitable examples. 4. Describe the Manufacturing of acetaldehyde with flow diagram 5. Discuss catalytic esterification. 6. Explain the process of manufacturing of vinyl acetate with flow diagram. 7. Discuss the liquid and vapour phase oxidation. 8. Describe the process of hydrogenation of vegetable oil with flow diagram. 9. Discuss various oxidizing agents. 10. Explain the process of manufacturing of chlorobenzene with diagram. 11. Describe the manufacturing of benzoic acid with diagram. 12. Manufacturing of ethyl acetate with flow diagram.				

MCQs for Internal Assessment (At least 8)

1. Which of the following is a unit process?
   a) Distillation
   b) Filtration
   c) Oxidation
   d) Crystallization

2. The sulfonating agent used in sulfonation of benzene is:
   a) Hydrochloric acid
   b) Sulfuric acid
   c) Acetic acid
   d) Nitric acid

3. Which gas is commonly used in hydrogenation (reduction) processes?
   a)Oxygen
   b) Nitrogen
   c) Hydrogen
   d) Methane

4. Which of the following is NOT a unit process?
   a) Halogenation
   b) esterification
   c) Evaporation
   d) Oxidation

5. In halogenation, which of the reagent is used?
   a) Chlorine gas
   b) Bromine
   c) Iodine
   d) All of the above

6. Which unit process introduces a chlorine group into an organic compound?
   a) Hydrogenation
   b) Halogenation
   c) Oxidation
   d) Sulfonation

7. The catalyst commonly used in hydrogenation is:
   a) $FeCl_3$
   b) $AlCl_3$
   c) Ni
   d) NaOH

8. Which of the following unit processes is commonly used in manufacturing of ethyl acetate?
   a) Esterification
   b) Halogenation
   c) Filtration
   d) Decantation

Course Category: **Major Lab**

120222 Industrial Chemistry Lab 10

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120222	Industrial Chemistry Lab 10	2	60	4 h	25+25= 50

Course Objectives:	1. To demonstrate the fundamental principles of chemical engineering unit processes such as oxidation, reduction, hydrolysis, nitration, and sulfonation through hands-on laboratory experiments. 2. To develop the ability to analyze, interpret, and correlate experimental data with theoretical concepts related to mass transfer, heat transfer, and reaction kinetics in unit processes. 3. To enhance practical skills in safe laboratory practices, process monitoring, and troubleshooting during chemical reactions and unit operations relevant to industrial applications.
Course Outcomes:	After completion of this course 1. Students will be able to conduct and analyze experiments related to key unit processes such as oxidation, nitration, sulphonation, amination and apply this knowledge to industrial chemical reactions. 2. Students will demonstrate the ability to identify factors affecting corrosion, evaluate corrosion rates under different conditions, and suggest appropriate prevention or control methods. 3. Students will gain hands-on experience in handling laboratory equipment, interpreting data, and applying theoretical knowledge to practical scenarios in chemical process and corrosion control.

Unit System	Contents	Incorporation of Pedagogies
Experiments	1. Preparation of nitrobenzene using mixed acid. 2. Preparation of benzenesulfonic acid using concentrated sulfuric acid. 3. Preparation of acylated aromatics such as acetophenone. 4. Preparation of esters like ethyl acetate from acetic acid and ethanol. 5. Preparation of soap from vegetable oil and NaOH. 6. Hydrolysis of Amides 7. Oxidation of Ethanol to Acetaldehyde 8. Preparation of alkenes like ethylene from ethanol using acid catalyst. 9. Laboratory-scale hydrogenation of an unsaturated compound. 10. Bromination of Phenol or Aniline 11. To Observe corrosion rate in different environments. 12. To Understand the role of air and water in rusting. 13. To Test the effectiveness of coatings on preventing corrosion. 14. To study the effect of pH on Corrosion.	• Students should be given suitable **pre- and post-lab** assignments and explanation revising the theoretical aspects of laboratory experiments prior to and after the conduct of each experiment. • **Hands-On Laboratory Sessions:** Provide regular hands-on laboratory sessions where students can directly apply theoretical knowledge to practical experiments. • **Demonstrations and Simulations:** Use virtual simulations for certain experiments to enhance accessibility and understanding. • **Flipped Classroom Model:** Encourage students to come to class prepared, promoting active participation. • **Interactive Workshops:** Provide opportunities for students to engage in discussions, ask questions, and seek clarification. • **Guest Lectures and Industry Connections:** Establish connections with professionals in the field to provide students with a broader perspective on chemical lab practices. • **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research.

References	1. Chemical Engineering Laboratory Manual – K. A. Gavhane 2. Practical Chemistry for Engineering Students – O.P. Vermani & A.K. Narula 3. Experimental Organic Chemistry: A Small-Scale Approach – Donald L. Pavia, Gary M. Lampman, George S. Kriz 4. Laboratory Experiments in Organic Chemistry – J.C. Ghosh 5. Engineering Chemistry (with Lab Manual) – Shashi Chawla 6. Corrosion Engineering Laboratory Manual – Dr. R. Subramanian 7. Corrosion Testing: Made Easy – A Guide for Non-Corrosion Engineers – Benjamin S. Craig 8. Laboratory Manual on Engineering Chemistry – Sudha Rani **Web resources:** 1. https://www.vlab.co.in/broad-area-chemical-engineering 2. https://uorepc-nitk.vlabs.ac.in/ 3. https://www.mtu.edu/chemical/facilities/teaching/operations/ 4. https://units.imamu.edu.sa/colleges/en/Engineering/studyprograms/Documents/ChE%20Courses%20Syllabi/Lab%20documents/Unit-Operation-Lab-Manual.pdf 5. https://sjce.ac.in/wp-content/uploads/2018/01/Chemical-Engineering-lab-manual-finalized.pdf 6. https://cache.org/teaching-resources-center/unit-ops 7. https://learncheme.com/virtual-laboratories/
Model Questions:	**NA**

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities — 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * — 10 Marks
- Submission of duly certified practical record — 05 Marks

Total — **25 Marks**

***Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations**

Section 2: External Assessment

- Exercise 1 (Organic Chem Practical) — 10 Marks
- Exercise 2 (Physical Chem Practical) — 10 Marks
- Viva-Voce (external) — 05 Marks

Total — **25 Marks**

Course Category**: Minor (Theory)**

120223 Minor Industrial Chemistry-2

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5	IV	120223	Minor Industrial Chemistry-2	2	30	2 Hrs	30+20=50

Course Objectives:	1. To understand the basics of various Units Operations. 2. To Understand the applications of Units Operations. 3. To understand mechanism of various Units Operations. 4. To Understand the applications of various industrial screens. 5. To understand the basics of surface chemistry.
Course Outcomes:	**After completion of the course student should** 1. Able to apply basic knowledge for application of specific unit operation. 2. Able to apply specific equipment for particular unit operation. 3. Able to differentiate the applications of various unit operation equipment's. 4. Able to identify the role of specific catalyst.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**General Idea about Mass Transfer Operations:** **Extraction:** Introduction, Selection of solvent, Single stage and multistage extraction, Mixer Settler, spray column. **Leaching:** Introduction, Single stage leaching, Percolation tank, Counter current multiple contact (Shank's system), Continuous counter current decantation.	8 Hrs	8 Marks	To enhance conceptual understanding and practical skills, a **blended teaching methodology** is employed, integrating the following strategies: **1. Inquiry-Based & Experimental Learning Hands-on Lab Work & Virtual Labs** for mass transfer operations **2. Application & Research-Based Learning** **3. Case-Based & Interdisciplinary Approach** connecting chemistry with industrial and environmental applications. 4. **Mini-Projects & Literature Reviews** to encourage analytical thinking. This **integrated approach** fosters **engagement, critical thinking, and practical competence**, ensuring a **dynamic and research-oriented** chemistry learning experience.
Unit II	**Crystallization:** Introduction Solubility, Saturation, Supersaturation, Nucleation, Crystal growth, Agitated tank crystallizer **Drying:** Introduction, Free moisture, Bound moisture, Moisture content on wet and dry basis, Equilibrium moisture content, Critical moisture content, Constant rate period, falling rate period, Drying Equipment's-Tray dryer, Drum dryer, spray dryer.	7 Hrs	7 Marks	
Unit III	**Mixing and Agitation:** Mixing of liquid with liquid, mixing of gases with liquids, mixing of solids with liquids, Impellers, Propellers, Turbines, Paddles, Flow pattern in agitated vessels, Unbaffled tanks, Prevention of swirling and vortex formation, Baffling, Banbury mixer, Pug mill, Ribbon blenders, Tumbling mixer, Double arm kneader.	8 Hrs	8 Marks	

Unit IV	**A) Surface Chemistry:** Adsorption, Mechanism of adsorption, Types of adsorption, Adsorption isotherms, -Langmuir, BET and Freundlich isotherm, Factors affecting adsorption, Applications of adsorption, Sols and their preparations, Coagulation, Emulsions, Gels, Surfactants. **B) Catalysis:** Introduction, Types of Catalysis-Homogeneous and heterogeneous, Mechanism, Characteristics of catalysts, Catalyst deactivation, Autocatalysis, Negative catalysis, Activation energy, Enzyme catalysis.	7 Hrs	7 Marks	
References	**Reference Books:** 1. Unit Operations of Chemical Engineering by W.L. McCabe and J. C. Smith and P. Harriott, McGraw-Hill. 2. Mass Transfer Operations by R. E.Treybal, McGraw-Hill. 3. Unit Operations- G. G. Brown, CBS Publications. 4. Principles of Physical Chemistry- B.R.Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing Co. 5. Principles of Surface Chemistry by Gabor A. Somorjai 6. Surface Chemistry and Catalysis by Gabor A. Somorjai and Yimin Li 7. Catalysis: Concepts and Green Applications by Gadi Rothenberg 8. Heterogeneous Catalysis: Fundamentals and Applications by J. M. Thomas and W. J. Thomas 9. Introduction to Surface Chemistry and Catalysis by Gabor A. Somorjai and Yimin Li (2nd Edition) 10. Unit Operations-II by K.A. Gavhane, Nirali Prakashan. **Web Resources** 1. https://archive.nptel.ac.in/courses/103/103/103103145 2. https://www.slideshare.net/slideshow/mass-transfer_operations-29040152/29040152 3. https://engineeringoperations.blogspot.com/2010/12/chemical engineering-interview_8752.html 4. https://onlinecourses.nptel.ac.in/noc21_cy45/preview 5. https://www.ornl.gov/group/surface-chemistry-and-catalysis 6. https://cbe.princeton.edu/research/surface-science-and-catalysis 7. https://www.sciencedirect.com/topics/engineering/mechanical-separation 8. https://encyclopedia.che.engin.umich.edu/separations-mechanical 9. https://www.accessscience.com/content/article/a412100			
Model Questions:	**Short Type** 1. Define liquid-liquid extraction operation. 2. Define leaching operation. 3. What is crystallization operation? 4. Give the applications of Drying operation. 5. Define Drying. 6. What is the purpose of extraction operation? 7. Give an account of Mixing of solids with liquids. 8. Discuss Prevention of swirling and vortex formation. 9. Discuss the various factors affecting adsorption 10. Discuss i) Autocatalysis ii) Negative catalysis			
	Long Type 1. Explain construction and working of spray column for extraction operation. 2. Discuss Continuous counter current decantation with diagram. 3. Discuss Counter current multiple contact the Shank system for leaching operation. 4. Describe the construction and working of Mixer settler for extraction operation. 5. Discuss the mechanism of crystallization. 6. Explain the construction and working of tray dryer with diagram.			

7. Explain the construction and working of spray dryer with diagram.
8. Describe the construction and working of drum dryer with diagram

	MCQs 1. The phase which is rich in solute is called as Phase. a) Raffinate b) solid c) Extract d) liquid 2. Separation of solid component from liquid is called as----- a) Evaporation b) Leaching c) Drying d) Distillation 3. Shank system is used for operation a) Distillation b) Drying c) Crystallization d) leaching 4. Separation of solid in the form of crystals from saturated solution is called as a) Drying b) Crystallization c) Extraction d) Distillation 5. Tray dryer is an example of dryer a) Direct b) Indirect c) Straight d) None of these 6. Spray dryer is an example of dryer. a) Batch b) Continuous c) Straight d) None of these 7. Concentration of solute in its saturated solution at a given temperature is called as a. Extraction b. solubility c. crystallization d. drying 8. What is the principle of mixing? a. Shear force b. Perpendicular force c. Gravitational force d. Centrifugal force 9. Which of the following type of paddle agitators are most commonly used? a. Two Bladed b. Three Bladed c. Four Bladed d. Two bladed and four bladed 10. An emulsifier is a substance which a. Stabilizes the emulsion b. coagulates the emulsion c. causes homogenesis of emulsion d. none of these 11. Which one of the following is not a catalysis category? a. Homogeneous b. Heterogeneous c. Artificial d. d. Enzymatic 12. Catalyst which are in same phase or state of reactant are called as____ catalyst a. negative b. homogeneous c. heterogeneous d. none of these

Course Category: **Minor Lab**

120224 Industrial Chemistry Lab- 11

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120224	Industrial Chemistry Lab- 11	2	60	4 h	25+25= 50

Course Objectives:	1. To develop a strong conceptual understanding of fundamental principles of various unit operations through hands-on experimental work. 2. To enhance analytical and problem-solving skills by applying theoretical knowledge to laboratory-based tasks.
Course Outcomes:	**Upon successful completion of this course, students will be able to:** 1. Apply basic knowledge to select the proper extraction method for separation of liquid components from their mixture 2. Perform extraction, crystallization etc. operations with correct way. 3. understand the adsorption phenomenon. 4. Apply the basic knowledge to choose the proper solvent for extraction operation. 5. Understand the effect of catalyst during the course of reaction.

Unit System	Contents	Incorporation of Pedagogies
Experiments	1. To determine the distribution coefficient of acetic acid between water and ethyl acetate. 2. To extract iodine from water into CCl_4 and observe partitioning. 3. To extract caffeine from tea leaves using water 4. Crystallization of benzoic acid using water as a solvent 5. Crystallization of benzoic acid using water and alcohol mixture as a solvent. 6. Crystallization of copper sulphate using water as a solvent. 7. Crystallization of sodium acetate using water as a solvent. 8. To study the adsorption of acetic acid from solution by activated charcoal and verify Freundlich's adsorption isotherm. 9. Surface Tension Measurement using Stalagmometer 10. To study the catalysis of ester hydrolysis using acid or base.	• **Hands-on Experimental Learning** Practical laboratory sessions for solution preparation, titration, and organic compound identification. • **Inquiry-Based Learning** – Encouraging students to analyze unknown solutions and predict concentrations based on calculations. • **Collaborative Learning** – Group discussions and peer review of experimental procedures and results. • **Problem-Based Learning (PBL)** Application of theoretical concepts to real-world scenarios, such as industrial and pharmaceutical solution preparations.

References

1. Chemical Engineering Laboratory Manual by K. A. Gavhane
2. Mass Transfer Laboratory Manual by R.K. Rajput
3. Chemical Engineering Laboratory Manual by G. K. Roy
4. Heat and Mass Transfer Lab Manual by V. K. Manglik
5. Experimental Methods in Chemical Engineering by V. S. Moholkar
6. Laboratory Manual in Mass Transfer Operations by D. C. Sikdar
7. Practical Chemical Engineering Unit Operations by J.M. Coulson
8. Laboratory Manual of Unit Operations in Chemical Engineering by S. K. Sinha
9. Engineering Chemistry lab manual by Dr. N. Rama Jyothi, Shine book publishing. 10.Practical Engineering Chemistry by Archana Thakur.
11. Engineering Chemistry Practical Book by Dr. Preeti Jain, Dr. S.L. Garg, Variety Books Publishers Distributers
12. Practical Industrial Chemistry by Zena N siddiqqui.
13. A Textbook on Experiments and Calculations in Engineering Chemistry By S.S Dara. S Chand Ltd.

Web resources:

1. https://people.iitism.ac.in/~download/lab%20manuals/chemical_engg/Mass%20Transfer%20Lab%20CHC305.pdf
2. https://www.rgukt.ac.in/assets/images/chemical/Mass_Transfer_OperationsLAB_MANUAL.pdf
3. https://www.kfu.edu.sa/en/Colleges/AhsaEngineering/Documents/ChE406%20Lab%20Manual.pdf
4. https://www.finitetechno.com/mass-transfer-lab/
5. https://faculty.chas.uni.edu/~manfredi/860-121/ORG%20LAB%20MAN%20S08.pdf
6. https://home.miracosta.edu/dlr/210exp5.htm

Model Questions:	NA

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

***Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations**

Section 2: External Assessment

- Exercise 1 (Inorganic Chem Practical) 10 Marks
- Exercise 2 (Organic Chem Practical) 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category**: GE/OE -4**

120225 Natural and Eco- friendly Dyes

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120225	**Natural and Eco-friendly Dyes**	2	30	2 Hrs	30+20=50

Course Objectives:	1. To introduce students to the historical background, significance, and advantages of using natural dyes over synthetic dyes. 2. To impart knowledge of various natural dye sources and teach methods for extracting and applying dyes from plant, animal, and mineral origins.
Course Outcomes:	After successful completion of the course, a student will be able to- 1. Understand the sources, extraction methods, and chemical composition of natural dyes derived from plants, minerals, and other natural materials. 2. Demonstrate the ability to prepare and apply natural dyes on various fabrics using sustainable and eco-friendly techniques. 3. Analyze the fastness properties (color durability) and environmental impact of natural dyes compared to synthetic alternatives.

Unit System	Contents	Work load Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Introduction to Dyes and Natural Colorants History and cultural significance of natural dyes Types of dyes: natural vs. synthetic Environmental and health benefits of homemade dyes (non-toxic, biodegradable, cost-effective) Basic chemistry of color and dye compounds Difference between synthetic and natural dyes Safety and sustainability in dye preparation	7 Hrs	7 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to improve practical understanding To correlation relevance of theoretical knowledge with real world. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Practical-Based Learning: Making Neem-Based Biopesticide Solution"**. **Any other innovative pedagogy as applicable.**
Unit II	Sources and Preparation of Natural Dyes Common dye sources from kitchen and garden: turmeric, spinach, beetroot, onion peel, hibiscus, tea, coffee, etc. Animal and mineral-based natural dyes (e.g., cochineal, indigo) Seasonal and regional availability of dye sources Extraction methods: boiling, soaking, fermentation Role of pH and temperature in color variation Storage and shelf life of natural dyes	8 Hrs	8 Marks	
Unit III	Dyeing Techniques and Fixation Types of fabrics suitable for homemade dyes (cotton, silk, wool) Mordants: natural fixatives like alum, vinegar, salt, lemon juice Dye Formulation Methods: boiling, soaking, fermentation, solvent extraction Concentration and consistency in dye preparation Preparation of liquid and powder forms of homemade dyes	7 Hrs	7 Marks	

Unit IV	Application Methods Suitable fabrics and materials (cotton, silk, wool, paper) Dyeing techniques: dip-dye, tie-dye, batik, block printing Designing with homemade dyes for crafts, garments, and décor Factors affecting dye uptake and fastness	8 Hrs	8 Marks	

References:

1. Natural Dyes: Sources, Chemistry and Applications By K. Venkataraman
2. Eco-Friendly Textiles: Dyes and Finishes By Mohd Yusuf
3. Natural Dyes for Textiles: Sources, Chemistry and Applications Edited by Padma Shree Vankar.
4. Handbook of Natural Colorants By Thomas Bechtold and Rita Mussak
5. Natural Dyes: Plants, Tradition, and People By Dominique Cardon
6. Textile Dyes: Dyeing Process and Environmental Impact Edited by Peter Hauser
7. The Art and Science of Natural Dyes: Principles, Experiments, and Results By Joy Boutrup and Catharine Ellis
8. Green Chemistry for Dyes Removal from Wastewater Edited by Sanjay K. Sharma
9. Natural Dyeing By Jackie Crook
10. Wild Color: The Complete Guide to Making and Using Natural Dyes By Jenny Dean

Web resources:

1. https://en.wikipedia.org/wiki/Natural_dye
2. https://textilefocus.com/sources-applications-natural-dyes/
3. https://www.skillshare.com/en/blog/a-guide-to-natural-dyes-make-fabric-dye-with-food-and-plants/
4. https://www.fibre2fashion.com/industry-article/3184/natural-plant-dyes
5. https://naturaldyes.ca/instructions

Model Questions:

Short Type (At least 6)

1. What is a natural dye?
2. Name two advantages of using natural dyes over synthetic dyes.
3. Give two examples of plant-based natural dye sources.
4. What is the role of a mordant in dyeing?
5. Name one eco-friendly mordant used in natural dyeing.
6. What part of the turmeric plant is used for dyeing?
7. Why are natural dyes considered environmentally friendly?
8. Name a natural dye that gives a red or pink color.
9. Mention two methods of extracting dye from plants.
10. What is indigo, and which plant is it derived from?
11. Name a natural dye that can be extracted from onion peels.
12. What is tie-dyeing in the context of natural dye application?

Long Type (At least 4)

1. Explain the differences between natural dyes and synthetic dyes in terms of composition, application, and environmental impact.
2. Discuss the historical significance and traditional uses of natural dyes in various cultures.
3. Describe the process of extracting dye from a plant source, such as turmeric or beetroot.
4. What are mordants? Explain their role in natural dyeing and compare natural and synthetic mordants.
5. List and explain different methods of applying natural dyes to fabrics. Include at least two techniques in detail.
6. Describe the environmental benefits of using eco-friendly dyes in the textile industry.
7. Explain the steps involved in preparing a homemade dye from kitchen waste.
8. List at least five plants used for natural dyeing and describe the color each produces.
9. What are the recent innovations and technologies in the field of eco-friendly dye production?
10. Compare the color fastness properties of natural dyes with those of synthetic dyes.

MCQ (At least 8)

1. Which of the following is a source of natural dye?
   A. Nylon
   B. Indigo plant
   C. PVC
   D. Acrylic
2. The yellow color from turmeric is due to:
   A. Chlorophyll
   B. Carotene
   C. Curcumin
   D. Xanthophyll
3. Eco-friendly dyes are primarily derived from:
   A. Petrochemicals
   B. Plastics
   C. Natural sources
   D. Synthetic resins
4. Which of the following is commonly used as a natural mordant?
   A. Alum
   B. Sulfuric acid
   C. Bleach
   D. Acetone
5. Onion peels can produce which shade of dye?
   A. Green
   B. Yellow-brown
   C. Blue
   D. Red
6. Which dye is obtained from the Lawsonia inermis plant?
   A. Indigo
   B. Henna
   C. Madder
   D. Saffron
7. What is the purpose of a mordant in natural dyeing?
   A. To bleach the fabric
   B. To increase water absorption
   C. To fix the dye to the fabric
   D. To soften the fabric
8. Natural dyes work best on which types of fabric?
   A. Polyester
   B. Nylon
   C. Cotton and silk
   D. Acrylic
9. Which part of the pomegranate is used as a natural dye?
   A. Seed
   B. Leaf
   C. Peel
   D. Flower
10. Which of the following is NOT an advantage of eco-friendly dyes?
    A. Biodegradable
    B. Non-toxic
    C. Long shelf-life like synthetics
    D. Sustainable
11. A green dye can be prepared from:
    A. Spinach leaves
    B. Beetroot
    C. Onion peel
    D. Turmeric

12. Which one of the following is a synthetic dye?
    A. Alizarin
    B. Henna
    C. Indigo (natural)
    D. Turmeric

Course Category: **Vocational Skill Course VSC-3**

120226 Industrial Chemistry Lab- 12 (Fundamentals of Titrimetric Analysis)

Level	Semester	Course Code	Course Name	Credits	Teachig Hours	Exam Duration	Max Marks
5.0	IV	120226	Industrial Chemistry Lab- 12 (Fundamentals of Titrimetric Analysis)	2	60	4 Hrs	50

Course Objectives:	1. To comprehend the theoretical foundations of acid-base, redox, complexometric, and precipitation titrations, including the role of indicators, equivalence points, and stoichiometry. 2. To gain hands-on experience in accurately preparing solutions, standardizing reagents, and performing titrations across various categories (e.g., acid-base, redox, EDTA, Mohr's method). 3. To accurately calculate molarity, percent composition, and unknown concentrations using titration data, applying correct formulas and error analysis. 4. To relate titration methods to real-world applications, such as quality control in food, pharmaceuticals, water treatment, and environmental analysis.
Course Outcomes:	1. Upon successful completion of this course, students will be able to: 2. Understand the Principles of Titration Techniques 3. Develop Proficiency in Performing Different Titration Methods 4. Analyze and Interpret Experimental Data 5. Apply Titration Techniques to Real-Life and Industrial Scenarios

Unit System	Contents	Incorporation of Pedagogies
	Acid-Base Titrations 1. Standardization of NaOH using Oxalic Acid 2. Determination of Acetic Acid Content in Vinegar 3. Determination of Citric Acid in Lemon Juice 4. Titration of Strong Acid (HCl) with Strong Base (NaOH) 5. Titration of Weak Acid (CH_3COOH) with Strong Base (NaOH) 6. Determination of Unknown Concentration of H_2SO_4 using NaOH 7. Back Titration of Calcium Carbonate in Chalk 8. Titration of Antacid Tablets to Determine Neutralizing Capacity. **B. Redox Titrations** 9. Standardization of $KMnO_4$ using Oxalic Acid 10. Estimation of Iron (Fe^{2+}) Using $KMnO_4$ 11. Estimation of Hydrogen Peroxide (H_2O_2) Using $KMnO_4$ 12. Titration of Sodium Thiosulfate with Iodine (Iodometry) 13. Estimation of Copper (II) using Iodometric Titration 14. Estimation of Vitamin C (Ascorbic Acid) by Iodine Titration	To enhance student engagement and learning outcomes, the following pedagogical approaches will be incorporated: • **Experiential Learning (Hands-on Laboratory Work)** a. Conduct guided experiments on the titration. • **Inquiry-Based Learning** a. Promote critical thinking by comparing different types of titrations. • **Collaborative Learning** a. Facilitate group-based experimental work to enhance teamwork and problem-solving skills. b. Conduct peer discussions on challenges and improvements in experimental procedures. • **Assessment through Reflective Learning** a. Encourage students to maintain lab journals for recording observations and interpretations. Conduct oral presentations and report writing to develop scientific communication skills.

References	1. Vogel's Textbook of Quantitative Chemical Analysis – G.H. Jeffery et al. 2. A Textbook of Practical Chemistry – V.S. Kulkarni, G.H. Hegde 3. Laboratory Manual in Organic and Inorganic Chemistry – R.K. Bansal 4. Practical Chemistry for Class 12 (NCERT) – NCERT (India) 5. Comprehensive Practical Chemistry (Laxmi Publications) – Dr. J.N. Gurtu & Dr. R. Kapoor 6. Practical Chemistry Lab Manual – O.P. Agarwal 7. Introductory Practical Chemistry – G.S. Sodhi 8. Analytical Chemistry: A Modern Approach to Analytical Science – David Harvey 9. Practical Analytical Chemistry – M. Satake, Y. Sugiura et al. 10. Experiments in General Chemistry – C. H. Sorum **Web resources:** 1. Acid-Base Titration Procedure https://alameda.edu/wp-content/uploads/2024/08/Titration-short-version-of-Lab-11.pdf 2. Redox Titration Lab Guide https://study.com/academy/lesson/redox-titration-lab.html 3. Complexometric Titration with EDTA https://chem.libretexts.org/Ancillary_Materials/Demos_Techniques_and_Experiments/General_La_Techniques/Titration/Complexation_Titration 4. Precipitation Titration: Determination of Chloride by the Mohr Method https://www.uobabylon.edu.iq/eprints/publication_3_16276_250.pdf 5. Iodometric Titration Procedure https://usptechnologies.com/iodometric-titration/
Model Questions:	**NA**

Distribution of Marks and the scheme of (VSC) Practical Examination is as follows:

Section I: Continuous Internal Assessment

- Continuous Assessment Tests (CAT) (At least three tests) * 15 Marks
- Submission of duly certified practical record 10 Marks

Total **25 Marks**

Section II: End Semester Examination (Internal only)

- Exercise 1 20 Marks
- Viva-Voce (internal) 05 Marks

Total **25 Marks**

Total (Section I and II) **50 Marks**

***Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations**

Course Category: **Skill Enhancement Course SEC-3**

120227 Industrial Chemistry Lab- 13 (Analytical Skills and Industrial chemical Processes)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120227	Industrial Chemistry Lab- 13 **(Analytical Skills and Industrial chemical Processes)**	2	60	4 Hrs	50

Course Objectives:	The intended objectives are: 1. To train students in the accurate use of analytical techniques such as titrations, gravimetric analysis, and instrumental methods for quantitative and qualitative assessment of chemical substances. 2. To provide practical exposure to the synthesis and processing of industrially important chemicals such as soaps, detergents, dyes, and polymers. 3. To enable students to understand and apply fundamental principles of chemical engineering and process chemistry in small-scale industrial setups. 4. To familiarize students with the methods of preparation, testing, and quality evaluation of key chemical products used in industries such as paints, pigments, lubricants etc.	
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Demonstrate the ability to perform volumetric and gravimetric analyses accurately and interpret results to assess the quality and composition of chemical substances. 2. Develop practical skills in synthesizing industrially important products such as soaps, detergents, dyes, and polymers, following standard manufacturing procedures. 3. Gain hands-on experience in the preparation, testing, and quality evaluation of industrial chemical products such as paints, pigments, lubricants, and cement.	
Unit System	**Contents**	**Incorporation of Pedagogies**

Experiments	**A. Analytical Chemistry & Quality Control** 1. Estimation of metal ions (e.g., Ca^{2+}, Mg^{2+}) using Complexometric titrations 2. Assay of active ingredients in pharmaceuticals (e.g., aspirin, paracetamol) 3. Assay of aniline 4. Iodometric titrations (e.g., determination of available chlorine in bleaching powder) 5. Gravimetric analysis: e.g., estimation of barium or sulfate **B. Industrial Chemical Processes** 1. Preparation of urea-formaldehyde 2. Preparation of phenol-formaldehyde resin 3. Preparation of soap. 4. Synthesis of dyes (e.g., azo dyes) 5. Preparation of biodiesel from vegetable oil via transesterification **C. Chemical Industries and Products** 1. Preparation and testing of synthetic detergents 2. Preparation of pigments or paints (e.g., white pigment like ZnO or TiO_2) 3. Viscosity measurement of lubricants using Ostwald viscometer 4. Determination of Acid value of lubricating oil. 5. Determination of saponification value of vegetable oil 6. Determination of iodine value of oil.	To enhance student engagement and learning outcomes, the following pedagogical approaches will be incorporated: • **Experiential Learning (Hands-on Laboratory Work)** a. Conduct guided experiments on the synthesis of industrially relevant compounds. • **Inquiry-Based Learning** a. Promote critical thinking by comparing conventional and green synthesis approaches. • **Collaborative Learning** a. Facilitate group-based experimental work to enhance teamwork and problem-solving skills. b. Conduct peer discussions on challenges and improvements in experimental procedures. • **Assessment through Reflective Learning** a. Encourage students to maintain lab journals for recording observations and interpretations. b. Conduct oral presentations and report writing to develop scientific communication skills.

References	1. Vogel's Textbook of Quantitative Chemical Analysis By: J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas 2. Laboratory Manual of Analytical Chemistry By: R.K. Mohapatra 3. Instrumental Methods of Analysis By: Willard, Merritt, Dean, Settle 4. Quality Control for Dummies By: Larry Webber, Michael Wallace 5. Laboratory Manual in Industrial Chemistry By: B.K. Sharma 6. Practical Industrial Chemistry By: R. Gopalan, D. Venkappayya, S. Nagarajan 7. Industrial Chemistry: A Manual for Practical Instruction By: W.L. Asbury 8. Experimental Industrial Chemistry By: J. Heitner and L.C. Currie 9. Quantitative Analysis: Laboratory Manual By: Daniel C. Harris 10. Practical Pharmaceutical Chemistry – Vol I By: A.H. Beckett and J.B. Stenlake 11. Laboratory Manual in Industrial Chemistry By: B.K. Sharma 12.Practical Chemistry for B.Sc. Students (Industrial Chemistry) By: O.P. Pandey, D.N. Bajpai, S. Giri 13. Industrial Chemistry: Laboratory Manual By: K.H. Davis and F.S. Berner **Web source:** 1. MIT OpenCourseWare – Analytical Chemistry Laboratory https://ocw.mit.edu/courses/chemistry/5-310-laboratory-chemistry-spring-2003/labs/ 2. Labmonk – Experiments in Analytical Chemistry https://labmonk.com/analytical-chemistry-experiments 3. https://nptel.ac.in/courses/103103209 4. https://labmonk.com/industrial-chemistry-experiments 5. Chemical Industry Related Experiments https://labmonk.com/category/industrial-chemistry 6. ScienceDirect – Industrial Chemistry Experimental Methods https://www.sciencedirect.com
Model Questions	**NA**

Distribution of Marks and the scheme of (SEC) Practical Examination is as follows:

Section I: Continuous Internal Assessment

- Continuous Assessment Tests (CAT) (At least three tests) * 15 Marks
- Submission of duly certified practical record 10 Marks

Total 25 Marks

Section II: End Semester Examination (Internal only)

- Exercise 1 20 Marks
- Viva-Voce (internal) 05 Marks

Total 25 Marks

Total (Section I And II) 50 Marks

***Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations**

Course Category: FP/CEP-II

120228 Industrial Chemistry Lab- 14 (FP/ CEP in Industrial Chemistry - II)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	120228	Industrial Chemistry Lab- 14 (FP/ CEP in Industrial Chemistry - II)	2	60	--	50

Course Objectives:	The intended objectives are: • To develop an appreciation of rural culture, lifestyle and wisdom amongst students. • To learn about the status of various agricultural and development programmes. • To understand the causes of distress and poverty faced by vulnerable households and explore solutions for the same. • To apply classroom knowledge of courses to field realities and thereby improve the quality of learning.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Gain an understanding of rural life, Indian culture and ethos and social realities 2. Develop a sense of empathy and bonds of mutuality with the local community 3. Appreciate significant contributions of local communities to Indian society and Economy 4. Learn to value the local knowledge and wisdom of the community 5. Identify opportunities for contributing to community's socio-economic improvements

Guidelines/ SoP for FP/CEP

For understanding key principles of CE, forms of CE, operational guidelines and implementation strategy please refer https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf

As per NEP 2020, students of B Sc. II of Semester III and IV need to perform a Field Project (FP) for TWO (2) credits i.e. 50 Marks. The guidelines regarding the field project are as follows:

1) The total time allocation for the student to carry out field project is 60 hours.
2) Students should participate in field-based projects under the supervision of faculty.
3) Assignment of project topics to individual students or groups of students (max 4 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
4) For a SURVEY based project related questionnaire (15 or more questions) should be prepared.
5) The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
6) If the project is related to work that does not involve survey work, then the questionnaire part can be replaced accordingly (e.g. Sample collection/Data collection/ Experimental base etc).
7) The student should compile all the relevant data and carry out its analysis.
8) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc.
9) The project report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.). Submit the project report with the Guide's signature to the department.
10) The oral /poster presentation for all the projects should be arranged in the department. To evaluate the project, examiner should be appointed by HoD.
11) The total project work including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

Some suggested forms of FP/ CEP are:

1. **Linking learning with community service:** For example, students of Industrial chemistry can conduct water and soil testing in local areas and share the results with the local community.
2. **Linking research with community knowledge:** Community-based Participatory Research (CBPR) approaches are gaining recognition in this regard. For example, students of Industrial chemistry can undertake research in partnership with the community on solid and liquid waste disposal.
3. **Knowledge sharing and knowledge mobilization:** These can take the forms of enumerations, surveys, awareness camps and campaigns, training, learning manuals/films, maps, study reports, public hearings, policy briefs, cleanliness and hygiene teachings, legal aid clinics, etc. For example, students can undertake a 'swachhta survekshana' and/or nutrition survey for mothers and children, and educate them about hygiene and nutrition.
4. **Social innovations by students:** The students can be encouraged to initiate learning projects with a social impact and supported by HEIs. Incubation of such social innovation projects by students can also have meaningful links to existing curriculum and courses.

A few suggested (not exclusive) areas which not only provide practical applications of Industrial chemistry concepts but also foster collaboration, education, and sustainable practices within the community. are:

1. Understanding the chemical foot prints of household products such as toothpaste, haircare, facecare food products etc
2. Enhance science literacy among school students through interactive chemistry demonstrations.
3. Managing organic waste to composting and improve soil health.
4. Explore the extraction and application of natural dyes as alternatives to synthetic dyes.
5. Identify and mitigate lead exposure risks in the community.
6. Implement a community-wide recycling initiative focusing on chemical waste and recyclable materials.
7. Introduce and demonstrate the principles of renewable energy sources, such as biofuels or solar energy.
8. Assess local air quality and raise awareness about pollution sources and mitigation strategies.
9. Educate community members on the safe use, storage, and disposal of household chemicals.
10. Assist local farmers in understanding soil nutrient content and composition to optimize crop production.
11. Evaluate local water sources for contaminants such as heavy metals, nitrates, and pH levels.

References	1. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 2. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program 3. https://www.immerse.education/study-tips/100-ideas-for-research-projects-in-chemistry/ 4. https://pubs.rsc.org/en/content/articlelanding/2021/rp/d0rp00374c 5. https://www.acs.org/education/student-communities/activities.html 6. https://www.nettercenter.upenn.edu/academically-based-community-service-chemistry- outreach
Model Questions:	**NA**

Distribution of Marks and the scheme of FP/CEP Examination is as follows:

- Students' performance 20 Marks
- Submission of duly certified FP/CEP report 20 Marks
- Presentation (PPT or Poster) 10 Marks

Total **50 Marks**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Degree of Bachelor of Science

Industrial Chemistry

Semester V and VI

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-27)
Under NEP 2020 (As per Uniform NEP Scheme)

SYLLABUS

Contents

TLE Scheme for THIRD YEAR: SEMESTER – V (Level 5.5)

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
5.5	Major-T	120230	Material Chemistry	2	2	30	9	20	6	50	20
5.5	Major-T	120231	Industrial Pollution	2	2	30	9	20	6	50	20
5.5	Major-T	120232	Heavy and Fine Chemicals	2	2	30	9	20	6	50	20
5.5	Major-P	120233	Industrial Chemistry Lab 15	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	120234	Elective Industrial Chemistry-1	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	120235	Industrial Chemistry Lab 16 A (Elective Industrial Chemistry-1)	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	120236	Elective Industrial Chemistry-2	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	120237	Industrial Chemistry Lab 16 B (Elective Industrial Chemistry-2)	2	4	25	10	25	10	50	20
5.5	Minor-T	120238	Minor Industrial Chemistry-3	2	2	30	9	20	6	50	20
5.5	Minor-P	120239	Minor Industrial Chemistry Lab 17	2	4	25	10	25	10	50	20
5.5	VSC-P	120240	Industrial Chemistry Lab -18 VSC (Industrial Materials and Analysis Laboratory)	2	4	-	-	50	20	50	20
5.5	SEC-P	120241	Industrial Chemistry Lab 19 SEC (Process Operations and Analytical Skills Development)	2	4	-	-	50	20	50	20
5.5	FP/CEP	120242	Industrial Chemistry Lab 20 (FP/ CES in Industrial Chemistry III)	2	4	-	-	50	20	50	20
5.5	Non Credit		Foundation of Artificial Intelligence	NC	2			30+20	9+6	50	20

Important:

- **VSC Should be Complementary to Major**
- **SEC must be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**
- As per Sant Gadge Baba Amravati University, Amravati Extra-Ordinary Notification No. No. 241/2025 Dated 24/12/2025 “Foundation of Artificial Intelligence” is the mandatory **Non Credit Course** compulsory course for all the UG students in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati to earn their degree
- NC is Non Credit Course
- Students must select **Any One** of the Major-Elective Courses (T1 to T2) with respective Practical Course in Semester V**.**

TLE Scheme for THIRD YEAR: SEMESTER – VI (Level 5.5)

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
5.5	Major-T	120243	Industrial Safety and Cost Estimation	2	2	30	9	20	6	50	20
5.5	Major-T	120244	Chromatography	2	2	30	9	20	6	50	20
5.5	Major-T	120245	Paper and Pulp	2	2	30	9	20	6	50	20
5.5	Major-P	120246	Industrial Chemistry Lab 21	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	120247	Elective Industrial Chemistry 3 (Green Chemistry and Polymers)	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	120248	Industrial Chemistry Lab 22 A	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	120249	Elective Industrial Chemistry 4 (Instrumentation Techniques)	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	120250	Industrial Chemistry Lab 22 B	2	4	25	10	25	10	50	20
5.5	Minor-T	120251	Minor Industrial Chemistry 4	2	2	30	9	20	6	50	20
5.5	Minor-P	120252	Minor Industrial Chemistry Lab 23	2	4	25	10	25	10	50	20
5.5	VSC-P	120253	Industrial Chemistry Lab 24 VSC	2	4	-	-	50	20	50	20
5.5	Intern/Apprenticeship	120254	FRS Lab 25 Internship /Apprenticeship/ OJT	4	8	-	-	50	20	50	20

Important:

- VSC Should be Complementary to Major has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

Students must select **Any One** of the Major-Elective Courses (T1 to T2) with respective Practical Course in Semester VI**.**

Examination and Assessment Process:

i. The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

ii. Exit options are provided with Certificate, Diploma and Basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a Four Years Multidisciplinary Degree Programme. Students will receive a Bachelor's degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.

iii. For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019).

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
A	Major	External & Internal	30/60	9/18	20/40	6/12	50/100	20/40	25/50	10/20	25/50	10/20	25/50	10/20
B	Minor		30/60	9/18	20/40	6/12	50/100	20/40	25/50	10/20	25/50	10/20	25/50	10/20
C	Generic/ Open Elective	Internal			50	20	50	20	--	--	50	20	50	20
D	VSC	Internal			50	20	50	20			50	20	50	20
	SEC	Internal	--	--	50	20	50	20			50	20	50	20
e	AEC (Eng. & One MIL Composite)	Internal			50	20	50	20						
	IKS (Generic)	Internal			50	20	50	20						
	VEC	Internal			50	20	50	20						
F	Internship/ Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. The evaluation/assessment shall be done by appointing external examiner by principal from Industry/Organisation/Academia. The mentor faculty shall be the internal examiner. It shall be evaluated by giving maximum 50 marks per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.											
	FP/CEP													
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the **best two out of three** in CAT examinations

iv. Internal assessment (CAT) shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal

Examinations as applicable) at the end of each semester.
The theory/practical examinations of all the Semesters shall be held as per the following Schedule

Sr.No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

*The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.
2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.
3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.
4. Provided that the student shall be eligible to appear for examination if -
   a. He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
   b. He/she has prosecuted a regular course of study in a university department/college affiliated to the University.
   c. He/she has in the opinion of the Principal shown satisfactory progress in his/her studies.
5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.
6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

Course Category: **Major (Theory)**

120230 Material Chemistry

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120230**	**Material Chemistry**	2	30	2 Hrs	30+20=50

Course Objectives:	1. To understand the basics of Material Chemistry. 2. To Understand the Industrial applications Ceramics, Refractories and glasses. 3. To understand mechanism of cement and polymer manufacturing.
Course Outcomes:	After completion of the course student should be able to 1. Explain the classification, composition, manufacturing processes, properties, and applications of cement, refractories, ceramics, and polymers. 2. Describe the principles involved in the production of Portland cement, refractory materials, ceramic products, and industrial polymers, and interpret the relationship between composition and properties. 3. Differentiate various types of cement, refractories, ceramics, and polymers based on their structure, properties, performance characteristics, and industrial applications. 4. Analyze the physical, thermal, mechanical, and chemical properties of engineering materials and evaluate their suitability for specific industrial and technological applications. 5. Apply fundamental knowledge of cement, refractory, ceramic, and polymer materials to solve basic industrial problems and appreciate recent developments in material science and technology.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**A) Ceramics:** Introduction, Types: structural clay products, white wares, earthenware and stoneware. Raw materials, manufacturing processes. General properties and applications. **B) Refractories:** Introduction, classification: Acid, basic and neutral refractories. Raw materials, manufacturing, properties and applications. Fire clay bricks, and high alumina bricks.	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply
Unit II	**Glasses:** Introduction, Types of glass with properties and applications: Soda lime glass or soft glass, potash or hard glass, lead or flint glass, optical glass, common glass. Raw materials and compositions. Manufacturing process. General properties and applications.	7 Hrs	7 Marks	
Unit III	**Cement:** Introduction, raw materials, types of cement, manufacturing processes: Wet, dry and semi-dry process. Sequence of operations, Setting and hardening of cement. Properties of cement. Specifications and testing of cement (tensile, compression, fineness, specific gravity). Additives for cement. Major engineering problems in cement manufacturing.	8 Hrs	8 Marks	
Unit IV	**Polymers:** Introduction, classification (Natural, artificial, inorganic, organic, thermo-setting, thermo-plastic). Classification of polymerization processes (addition and condensation polymerization without mechanism). Manufacturing processes, properties and applications of: -polyethylene, polystyrene, polyvinyl chloride (PVC),	7 Hrs	7 Marks	

	polyester (PET), Teflon, phenol formaldehyde and urea formaldehyde resins.			theoretical knowledge. **Any other innovative pedagogy as applicable.**
References:	1. Engineering Chemistry by Jain, P. C. & Jain, M. (Dhanpat Rai Publications, New Delhi) 2. A Textbook of Engineering Chemistry by Shashi Chawla (Dhanpat Rai & Co.) 3. Industrial Chemistry by B. K. Sharma (Goel Publishing House) 4. Industrial Chemistry by R. K. Das (Kalyani Publishers) 5. Cement Chemistry and Manufacturing by J. A. Taylor (CRC Press) 6. The Chemistry of Cement and Concrete by Lea, F. M. (Butterworth-Heinemann) 7. Refractories by Norton, F. H. (McGraw-Hill Book Company) 8. Refractories: Production and Properties by Chester, J. H. (Iron and Steel Institute) 9. Polymer Science by V. R. Gowariker, N. V. Viswanathan & Jayadev Sreedhar (New Age International Publishers) 10. Polymer Science and Technology of Plastics and Rubbers by P. Ghosh, (Tata McGraw-Hill) **Web resources:** 1. https://nptel.ac.in 2. https://epgp.inflibnet.ac.in 3. https://ocw.mit.edu 4. https://ceramics.org 5. https://polymerdatabase.com			
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. Define cement. 2. What is meant by the setting and hardening of cement? 3. Give the role of gypsum in cement manufacture. 4. What are refractory materials? 5. Define ceramics and give two examples. 6. Define polymer with suitable examples. 7. Define thermoplastics polymer. 8. Define thermosetting polymer.			
	Answer in brief (At least 6) (3 Marks each) 1. Differentiate between acidic and basic refractories 2. What are the essential raw materials used in ceramic manufacture? 3. State any two properties of ceramic materials. 4. Discuss the properties required for a good refractory material and their significance. 5. Discuss the types of ceramic materials. 6. Discuss the classification of polymers based on source. 7. Explain addition polymerization with suitable examples.			
	Answer in Detail (At least 4) (6 Marks each) **1.** Describe the manufacturing process of Portland cement by the wet process with a neat flow diagram. 2. Explain the chemical composition of cement and discuss the functions of major constituents. 3. Discuss the various types of cement and their industrial applications. 4. Classify refractories on the basis of chemical nature and explain each with suitable examples. 5. Describe the manufacture, properties, and applications of high alumina refractories. 6. Explain the manufacturing process of ceramics with a suitable flow chart. 7. Explain condensation polymerization with suitable examples 8. Describe the manufacture, properties, and applications of polyethylene. 9. Describe the manufacture, properties, and applications of PVC.			
	MCQs for Internal Assessment (At least 4) The major constituent of Portland cement is: (A) Silica (B) **Lime** (C) Alumina (D) Gypsum			

	2. Gypsum is added to cement to: (A) Increase strength (B) Improve color (C) **Control setting time** (D) Increase density 3. The kiln used in cement manufacture is: (A) Blast furnace (B) **Rotary kiln** (C) Cupola furnace (D) Muffle furnace 4. Silica refractory belongs to: (A) **Acidic refractory** (B) Basic refractory (C) Neutral refractory (D) Composite refractory 5. Refractories are mainly used for: (A) Electrical insulation (B) **Thermal insulation and high-temperature resistance** (C) Water purification (D) Lubrication 6. Which property is characteristic of ceramics? (A) High ductility (B) **High thermal resistance** (C) High malleability (D) Low hardness 7. Porcelain is a type of: (A) Polymer (B) Metal alloy (C) **Ceramic** (D) Composite 8. Bakelite is an example of: (A) Thermoplastic (B) Elastomer (C) **Thermosetting polymer** (D) Copolymer 9. PVC stands for: (A) **Polyvinyl Chloride** (B) Polyvinyl Carbonate (C) Polyvinyl Cellulose (D) Polyvinyl Compound 10. Nylon-6,6 is produced by: (A) Addition polymerization (B) **Condensation polymerization** (C) Emulsion polymerization (D) Bulk polymerization

Course Category: **Major (Theory)**

120231 Industrial Pollution

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120231**	**Industrial Pollution**	2	30	2 Hrs	30+20=50

Course Objectives:	After completion of this course, students will be able to: 1. Understand the fundamentals of industrial pollution, its sources, classification, and environmental impacts on air and water resources. 2. Study the characteristics, causes, and effects of water and air pollutants generated from various industrial processes. 3. Learn methods for monitoring, analysis, and assessment of water and air quality using standard techniques and environmental regulations. 4. Acquire knowledge of pollution prevention and control technologies employed for the treatment of industrial effluents and gaseous emissions.
Course Outcomes:	Upon successful completion of the course, students will be able to: 1. Explain the sources, types, and environmental consequences of industrial water and air pollution. 2. Analyze the physical, chemical, and biological parameters used for assessing water and air quality and interpret monitoring data. 3. Evaluate industrial wastewater characteristics and recommend suitable treatment methods for the removal of pollutants. 4. Describe the principles and operation of air pollution control devices and emission reduction technologies used in industries. 5. Apply environmental standards, regulations, and pollution management strategies to minimize industrial pollution and promote sustainable industrial development.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	A) Classification of water: Sea water, surface water (river, lake, pond) and ground water (well, tube-well, stream); their properties in brief. B) Water quality parameters & assessment: pH, hardness, alkalinity, acidity, TDS, DO, COD, BOD. IS and WHO standards of water quality.	78 Hrs	8 Marks	1. **Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. 2. **Hands-On Models**: use of model 3. **Problem-Solving Sessions**: Organize regular problem-solving sessions. 4. Explore virtual labs and simulations to enhance understanding of the topic. 5. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. 6. Ask students to create concept maps that illustrate the relationships between different concepts.
Unit II	A) Inorganic Pollutants (sources and effects on water quality): Heavy metals, Pb, Hg, As, Cd, Cr, Ni, Cu, mineral acids, alkalis B) Organic Pollutants (sources and effects on water quality): Phenols, detergents, dyes, plastics, oils, greases etc. Water pollution due to paper and sugar industries.	7 Hrs	7 Marks	
Unit III	Waste Water Treatment: Industrial and sewage water treatments- A) Primary: Sedimentation, Coagulation and Flocculation. B) Secondary Treatment: Biological Methods a) Aerobic: Activated sludge process, Trickling filter process and oxidation ponds. b) Anaerobic Methods C) Tertiary Treatment: Chemical Methods for Inorganic Chemicals- Precipitation, electrolysis, ion–exchange, evaporation and adsorption	8 Hrs	8 Marks	

Unit IV	**A) Air Pollution due to Industries:** Classification of Air Pollutants: Sources and effects on human being, plants and materials. of oxides of carbon, sulphur, nitrogen, hydrocarbon and particulates. **B) Industries as Source of Air Pollution:** Steel Industries, Thermal Power Plants, paper and pulp industries. **C) Methods of Control of Air Pollution:** Electrostatic precipitators, scrubbing, filters mist eliminator.	7 Hrs	7 Marks	7. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. 8. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. 9. **Any other innovative pedagogy as applicable.**
References:	1. Environmental Chemistry by A. K. De, New Age International Publishers 2. Environmental Pollution and Control Engineering by C. S. Rao, New Age International Publishers 3. Environmental Science and Engineering by J. G. Henry & G. W. Heinke, Pearson Education 4. Introduction to Environmental Engineering and Science by Gilbert M. Masters & Wendell P. Ela, Pearson 5. Water Supply and Sanitary Engineering by G. S. Birdie & J. S. Birdie, Dhanpat Rai Publishing Company 6. Environmental Engineering: A Global Perspective by Nelson L. Nemerow, Franklin J. Agardy, Patrick Sullivan & James A. Salvato, Wiley 7. Wastewater Engineering: Treatment and Resource Recovery by Metcalf & Eddy, George Tchobanoglous, H. D. Stensel et al., McGraw-Hill Education 8. Air Pollution: Its Origin and Control by Kenneth Wark, Cecil F. Warner & Wayne T. Davis, Pearson 9. Environmental Pollution Control Engineering by C. S. Rao, New Age International Publishers 10. Standard Methods for the Examination of Water and Wastewater by American Public Health Association, American Water Works Association & Water Environment Federation, APHA Press **Web Resources:** 1. https://www.epa.gov 2. https://cpcb.nic.in 3. https://cpcb.nic.in 4. https://www.unep.org 5. https://www.neeri.res.in			
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. Define classification of water and explain any two types of water based on usage. 2. What is Biological Oxygen Demand (BOD)? 3. What are organic pollutants? Give two examples. 4. What are primary air pollutants? 5. What are secondary air pollutants? 6. List any four major sources of air pollution. 7. What is the purpose of air quality monitoring?			
	Answer in brief (At least 6) (3 Marks each) 1. Mention any two industries that significantly contribute to air pollution. 2. Explain natural and anthropogenic sources of air pollution with suitable examples. 3. Give two examples of inorganic pollutants found in water. 4. What is the purpose of sedimentation in water treatment? 5. Discuss the classification of air pollutants based on origin, physical state, and chemical composition. 6. Discuss the sources, effects, and control measures of inorganic pollutants in aquatic environments.			
	Answer in Detail (At least 4) (6 Marks each) 1. Discuss the classification of water on the basis of source, quality, and intended use with suitable examples. 2. Explain the physical, chemical, and biological parameters used for evaluating water quality. 3. Describe the sources, environmental impact, and methods of removal of organic pollutants			

	from wastewater. 4. Explain the various stages involved in municipal water and wastewater treatment processes with a flow diagram. 5. Explain the causes, major pollutants, environmental impacts, and control measures of industrial air pollution. **6.** Describe various methods and instruments used for monitoring air pollutants and assessing air quality.
	MCQs for Internal Assessment (At least 4) 1. Which of the following is classified as groundwater? (A) River water (B) Lake water (C) **Water obtained from wells and aquifers** (D) Rainwater 2. Which parameter indicates the amount of dissolved oxygen required by microorganisms to decompose organic matter in water? (A) pH (B) Turbidity (C) **BOD** (D) Hardness 3. Which of the following is an inorganic pollutant? (A) Phenol (B) Pesticide (C) **Mercury** (D) Detergent 4. Which of the following is an organic pollutant? (A) Cadmium (B) **Benzene** (C) Lead (D) Nitrate 5. Which process is commonly used for disinfection of drinking water? (A) Aeration (B) Coagulation (C) **Chlorination** (D) Sedimentation 6. Sulfur dioxide is mainly emitted from: (A) Textile industries (B) Fertilizer industries (C) **Combustion of sulfur-containing fossil fuels** (D) Food processing industries 7. Ozone present in photochemical smog is a: (A) Primary pollutant (B) **Secondary pollutant** (C) Natural pollutant (D) Biological pollutant 8. Air Quality Index (AQI) is used to: (A) Measure water hardness (B) **Assess ambient air quality** (C) Determine soil fertility (D) Measure wastewater flow

Course Category: **Major (Theory)**

120232 Heavy and Fine Chemicals

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120232**	**Heavy and Fine Chemicals**	2	30	2 Hrs	30+20=50

Course Objectives:	After successful completion of the course, students will be able to: 1. Understand the principles, raw materials, process technology, and manufacturing methods of heavy chemicals and fine chemicals used in chemical industries. 2. Study the industrial production, extraction techniques, processing operations, and quality control of essential oils obtained from natural sources. 3. Learn the manufacturing, refining, purification, and quality evaluation of edible oils and their industrial applications.
Course Outcomes:	Upon successful completion of the course, students will be able to: 1. Describe the raw materials, manufacturing processes, process flow diagrams, and industrial applications of major heavy chemicals and fine chemicals. 2. Explain the extraction, isolation, purification, and quality assessment methods employed in the manufacture of essential oils. 3. Discuss the production, refining, quality control parameters, and commercial significance of edible oils in food and allied industries. 4. Evaluate industrial manufacturing practices with respect to process efficiency, product quality, safety requirements, environmental impact, and economic feasibility.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Manufacturing of the following: Ammonia, nitric acid, ammonium sulphate, ammonium nitrate, caustic soda, chlorine, ammonium phosphate, superphosphate, triple superphosphate, urea with reference to following considerations: i) Consumption pattern ii) Raw materials	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. **Any other innovative pedagogy as applicable.**
Unit II	Manufacturing of the following: Lime, calcium carbide, silicon carbide, fluorine, sodium carbonate, sulphuric acid, hydrochloric acid, soda ash by Solvay process, with reference to following considerations-: i) Consumption pattern ii) Raw materials	7 Hrs	7 Marks	
Unit III	Essential Oils: Introduction, General properties, chemical constituents, extraction methods of essential oils -: Steam distillation, solvent extraction and expression. Properties and uses of following essential oils- menthol, citral, camphor, turpentine.	7 Hrs	7 Marks	
Unit IV	Edible Oil: Manufacturing of Soyabean oil by solvent extraction process, refining of crude vegetable oil. Hydrogenation of vegetable oil (Dry and wet processes), saponification value, iodine value, acid value and ester value. Manufacturing of soap, recovery of glycerin, cleansing action of soap.	8 Hrs	8 Marks	

References:	**Text books:** 1. Shreve's Chemical Process Industries by George T. Austin, McGraw-Hill Education 2. Chemical Process Industries by R. Norris Shreve and Joseph A. Brink Jr., McGraw-Hill 3. Industrial Chemistry by B. K. Sharma, Goel Publishing House, Meerut 4. A Textbook of Industrial Chemistry by P. C. Jain and Monica Jain, Dhanpat Rai Publishing Company 5. Industrial Chemistry byV. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, Khanna Publishers 6. Essential Oil Crops by E. A. Weiss, CAB International 7. Technology of Edible Oils and Fats by M. M. Chakrabarty, Allied Publishers 8. Industrial Chemistry Including Chemical Engineering – K. Jain and S. C. Sharma Publisher: Vishal Publishing Co. **Reference Books:** 1. Industrial Organic Chemistry by Klaus Weissermel and Hans-Jürgen Arpe, Wiley-VCH 2. Bailey's Industrial Oil and Fat Products by Edited by Fereidoon Shahidi, Wiley 3. Handbook of Essential Oils: Science, Technology, and Applications Edited by K. Hüsnü Can Başer and Gerhard Buchbauer, CRC Press 4. The Chemistry and Technology of Oils and Fats and Their High Fat Products by M. J. Lawson, Blackwell Scientific Publications 5. Chemical Engineering Design and Process Economics by Gavin Towler and Ray Sinnott, Elsevier **Web Resources:** 1. https://fertechinform.org 2. https://www.faidelhi.org 3. https://www.sciencedirect.com 4. https://www.essentialchemicalindustry.org 5. https://www.aiche.org 6. https://www.sciencedirect.com
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. Why is ammonium nitrate widely used as a nitrogenous fertilizer? 2. What is the difference between Monoammonium Phosphate (MAP) and Diammonium Phosphate (DAP)? 3. Name the raw materials used for the manufacture of superphosphate. 4. Define iodine value of an oil or fat. 5. What is saponification? 6. Mention one industrial use of menthol. 7. From which plant source is turpentine oil obtained?

	Answer in brief (At least 6) (3 Marks each) 1. What is the role of nickel catalyst in hydrogenation of vegetable oils? 2. Why is hexane commonly used as a solvent in soybean oil extraction? 3. Explain the manufacture of soap with chemical reactions and a process flow diagram. 4. Discuss the industrial manufacture of ammonium nitrate with process flow diagram, reactions, and uses. 5. Discuss the hydrogenation of vegetable oils with suitable Diagram. 6. Describe the manufacture of urea with a neat flow sheet and chemical reactions.
	Answer in Detail (At least 4) (6 Marks each) 1. Explain the manufacture of ammonium sulphate from ammonia and sulphuric acid, including reactions and applications. 2. Explain the manufacture of Monoammonium Phosphate (MAP) and Diammonium Phosphate (DAP) fertilizers. 3. Explain the manufacture of triple superphosphate (TSP) with reactions and uses. 4. Describe the Contact Process for the manufacture of sulphuric acid with a labelled flow sheet and reactions. 5. Explain the Ostwald process for nitric acid manufacture, highlighting the role of catalyst and operating conditions. 6. Discuss the industrial manufacture of hydrochloric acid by direct synthesis and by-product recovery methods. 7. Explain the manufacturing of soybean oil by the solvent extraction process with a neat flow diagram and discuss its advantages over mechanical pressing. 8. Discuss the extraction, composition, properties, and industrial applications of turpentine oil.
	MCQs for Internal Assessment (At least 4) 1. Which of the following is considered a **heavy chemical**? (A) Perfume (B) Citric acid (C) **Sulfuric acid** (D) Vanillin 2. Which method is most commonly used for the extraction of essential oils from aromatic plants? (A) Filtration (B) **Steam distillation** (C) Sedimentation (D) Crystallization 3. Urea is manufactured industrially from: (A) Ammonia and sulphuric acid (B) **Ammonia and carbon dioxide** (C) Nitrogen and hydrogen (D) Calcium carbonate and ammonia 4. Ammonium sulphate contains approximately: (A) **21% Nitrogen** (B) 46% Nitrogen (C) 16% Nitrogen (D) 10% Nitrogen 5. The principal raw material for ammonium nitrate manufacture is: (A) Sulphuric acid (B) Phosphoric acid (C) **Nitric acid and ammonia** (D) Lime and gypsum 6. Single superphosphate is produced by treating rock phosphate with: (A) Nitric acid (B) Hydrochloric acid (C) **Sulphuric acid** (D) Acetic acid 7. Hydrochloric acid is obtained by direct combination of: (A) Hydrogen and oxygen (B) **Hydrogen and chlorine** (C) Chlorine and sulphur (D) Nitrogen and hydrogen 8. The most commonly used solvent for extraction of soybean oil is: (A) Ethanol (B) Benzene

	(C) **Hexane** (D) Acetone 9. Soap is produced by the reaction of fats/oils with: (A) HCl (B) H_2SO_4 (C) **NaOH or KOH** (D) NH_4OH 10. Turpentine oil is obtained mainly from: (A) Citrus fruits (B) **Pine trees** (C) Mint plants (D) Rose flowers

Course Category: **Major Lab**

120233 Industrial Chemistry Lab 15

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120233**	Industrial Chemistry Lab 15	2	60	4 h	25+25= 50

Course Objectives:	After successful completion of the practical course students should able to 1. Understand and perform industrial chemical analyses related to cement, glass, ceramics, polymers, fertilizers, water, air, and oils using standard laboratory techniques. 2. Develop practical skills in synthesis, characterization, and quality control of industrial products such as polymers, fertilizers, cement, ceramics, and edible oils. 3. Apply environmental monitoring and pollution assessment methods for determining water quality, wastewater treatment efficiency.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Perform laboratory experiments for the analysis and quality evaluation of cement, glass, ceramics, fertilizers, essential oils, and edible oils using appropriate analytical methods. 2. Synthesize and characterize industrially important polymers and resins**,** and determine their physical and chemical properties. 3. Determine the composition and quality characteristics of nitrogenous fertilizers and edible oils**,** and assess their compliance with industrial quality standards. 4. Apply principles of industrial chemistry, environmental management, data analysis, and laboratory safety for solving practical problems encountered in chemical industries and environmental laboratories. 5. Prepare accurate laboratory records, analyze experimental results, and communicate scientific findings effectively through technical reports and presentations

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	Discussion regarding various sources of water. To discuss the various industrial pollutants. To note down the physical characteristics of various contaminated water samples and discuss. To analyze the sources of water pollution. To discuss various types of cement and their applications.	1. Laboratory-Based Learning Estimation of alkalinity, hardness, COD, BOD, chlorides in wastewater pH and turbidity measurements 2. Experiential Learning Collecting water samples from nearby industries or rivers Visiting cement industries or wastewater treatment plants 3. Problem-Based Learning "Why does cement fail quality standards?" "How can wastewater be treated before discharge?" 4. Project-Based Learning Design of simple wastewater treatment models 5. Inquiry-Based Learning Encourage students to investigate: Variation in water quality parameters with seasons Efficiency of different treatment methods 6. Industry-Oriented Learning Industrial case studies Internship or field training opportunities 7. ICT-Enabled Teaching Simulation videos of cement manufacturing and treatment plants 8. Collaborative Learning Sample collection
Experiments	Determination of fineness of cement by sieve analysis. Determination of softening point of glass. Estimation of silica content in cement sample. Estimation of iron content in cement sample. Preparation of urea-formaldehyde resin. Preparation of phenol-formaldehyde (Bakelite) resin. Determination of pH of water samples. Determination of total dissolved solids (TDS) in water. Determination of total hardness of water by EDTA method. Determination of dissolved oxygen (DO) by Winkler method. Determination of turbidity of water sample. Determination of moisture content in fertilizer. Extraction of essential oil from orange peel by steam distillation. Determination of acid value of edible oil. Determination of saponification value of edible oil. Determination of iodine value of edible oil.	

		Laboratory analysis 9. Outcome-Based Learning Ability to analyze cement quality parameters Understanding of pollution control techniques 10. Environmental and Sustainability-Oriented Pedagogy Recycling of industrial waste Water conservation and reuse. Any other innovative pedagogy as applicable.
Suggested Group activity	Preparation of polymers: Student groups prepare different polymers and study their properties and discuss their industrial applications. Flowchart Preparation Activity Model and Chart Presentation Mini Research Project Case Study Discussion	
References	Hand Book of Water and Wastewater Analysis by Kanwaljit Kaur, Atlantic Publishers & Distributors. Environmental Chemistry by A. K. De, New Age International publishers. Environmental Engineering by Peavy, Rowe and Tchobanoglous, McGraw-Hill Education India. A Textbook of Environmental Chemistry and Pollution control by S. S. Dara, S. Chand Publications Environmental Pollution Analysis by S. M. Khopkar, New Age International publishers. Practical Environmental Analysis by K. R. Aneja, Ane Books India Web Resources: https://nptel.ac.in https://www.services.bis.gov.in https://www.epa.gov/environmental-topics/water-topics https://cpcb.nic.in https://nptel.ac.in/courses/105107123 https://chemcollective.org https://www.youtube.com	
Model Questions:	NA	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

Active participation in activities	10 Marks
Continuous Assessment Tests (CAT) (At least three tests) *	10 Marks
Submission of duly certified practical record	05 Marks
Total	25 Marks

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

Exercise 1 (Inorganic Chem Practical)	10 Marks
Exercise 2 (Organic Chem Practical)	10 Marks
Viva-Voce (external)	05 Marks
Total	25 Marks

Course Category: Major- Elective (Theory)
120234 Elective Chemistry-1 (Polymer and Polymerization)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	120234	Elective Chemistry-1 (Polymer and Polymerization)	2	30	2 Hrs	30+20=50

Course Objectives:	To introduce students to the basic concepts of Polymer Chemistry, classification of polymers, and different polymerization techniques. To develop understanding of the preparation, properties, processing, and industrial applications of natural and synthetic polymers. To familiarize students with modern developments in polymer science, including biodegradable polymers, conducting polymers, and environmental aspects of polymer materials.
Course Outcomes:	After successful completion of the course, students will be able to: Explain the structure, classification, nomenclature, and properties of polymers and polymeric materials. Describe various polymerization methods such as addition, condensation, bulk, suspension, emulsion, and copolymerization processes. Correlate the physical and chemical properties of polymers with their industrial applications in plastics, rubbers, fibers, coatings, and adhesives. Analyze the importance of advanced and eco-friendly polymers, including biodegradable and conducting polymers, in modern technology and sustainable development.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Introduction to Polymers and Polymerization Definition and classification of polymers, Basic concepts: monomer, repeat unit, degree of polymerization. Types of polymers: Natural and synthetic polymers, Thermoplastic and thermosetting polymers, Elastomers and fibers Classification of polymerization reactions: Addition polymerization, Condensation polymerization Molecular weight of polymers: Number average and weight average, Polydispersity index.	8 Hrs	8 Marks	Interactive Lectures: Use multimedia presentations, interactive slides, and animations. Hands-On Models: use of model Problem-Solving Sessions: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. Flip-Class: Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. Inquiry-Based Learning: Explore topics through questioning, investigation, and research. Case-Based Learning: Analyze and discuss
Unit II	**Addition Polymerization Techniques** Free radical polymerization: Mechanism: initiation, propagation, termination, Inhibitors and retarders Ionic polymerization: Cationic and anionic polymerization, Copolymerization: Types of copolymers, Copolymerization reactions Preparation, properties and applications of polyethylene, PVC and polystyrene.	7 Hrs	7 Marks	
Unit III	**Condensation Polymerization and Industrial Polymers** Principles of condensation polymerization, Step-growth polymerization mechanism, Preparation, properties and applications of: Nylon 6,6, Terylene (PET), nylon 6, Bakelite. Biodegradable polymers: Introduction and importance Examples: PLA, PHBV	8 Hrs	8 Marks	
Unit IV	**Polymer Processing, Properties and Recent Developments** Polymer additives: Plasticizers, Stabilizers, Fillers, Antioxidants,	7 Hrs	7 Marks	

	Colouring agents Polymer processing methods: Injection moulding, Extrusion, Compression moulding, Blow moulding Properties of polymers: Mechanical properties, Thermal properties, Electrical properties Polymer degradation: Thermal degradation, Photodegradation, Biodegradation			real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable.

References:

1. Principles of Polymerization by George Odian, Wiley-Interscience
2. Polymer Science by V. R. Gowariker**,** N. V. Viswanathan**,** and Jayadev Sreedhar, New Age International
3. Textbook of Polymer Science by Fred W. Billmeyer Jr., Wiley-Interscience
4. Polymer Chemistry, by P. Bahadur and N. V. Sastry, New Age International Publishers
5. Introduction to Polymer Chemistry by R. B. Seymour and C. E. Carraher Jr.**,** Marcel Dekker Inc.
6. Fundamentals of Polymers by Anilkumar and Rakshit Ameta, Springer
7. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press
8. Handbook of Industrial Polymers by Samir Chanda and Salil K. Roy.,
9. Industrial Polymers by C. V. S. Murthy**,** New Age International
10. Polymer Technology by H. F. Mark and J. H. Miles and D. H. Briston, Butterworth-Heinemann
11. Polymer Chemistry: An Introduction by Malcolm P. Stevens, Academic Press / Oxford University Press
12. Engineering Chemistry by Jain, P.C. and Jain, Monika, Dhanpat Rai Publishing Company

Web Resources

1. https://www.acs.org/education/resources/highschool/chemmatters/articles/polymer-chemistry.html
2. https://polymerdatabase.com
3. https://www.rsc.org/topics/polymers
4. MIT OpenCourseWare – Polymer Science
5. https://www.sciencedirect.com/topics/chemistry/polymerization

Model Questions:

Short Type (At least 6) (1 Marks each)

1. Define polymer and monomer with suitable examples.
2. What is addition polymerization? Give one example.
3. Define free radical polymerization.
4. Name any two important industrial polymers and their applications.
5. What is injection molding?
6. Define biodegradable polymers.

Answer in brief (At least 6) (3 Marks each)

1. What is condensation polymerization? Give one example.
2. Differentiate between natural polymers and synthetic polymers.
3. Discuss bulk polymerization.
4. Discuss the preparation, properties and applications of industrial polymers such as Nylon 6.
5. Discuss the physical, mechanical and thermal properties of polymers.
6. Explain Injection molding technique for polymerization.

Answer in Detail (At least 4) (6 Marks each)

1. Explain the classification of polymers based on source, structure and thermal behavior with suitable examples.
2. Describe the concept of polymerization and discuss various factors affecting polymerization reactions.
3. Explain the mechanism of free radical polymerization, including initiation, propagation and termination steps.
4. Discuss bulk, solution, suspension and emulsion polymerization techniques with their advantages and limitations.
5. Explain the mechanism of condensation polymerization with suitable examples such as nylon-6,6 and polyester.
6. Discuss the preparation, properties and applications of industrial polymers such as Nylon, Bakelite and PET.
7. Explain various polymer processing techniques such as injection molding, extrusion, compression molding and blow molding.

	8. Describe recent developments in biodegradable polymers and nanocomposites.
	MCQs for Internal Assessment (At least 4) 1. The repeating unit in a polymer is derived from: A) Catalyst B) **Monomer** C) Solvent D) Plasticizer 2. Which of the following is a natural polymer? A) Polyethylene B) PVC C) **Cellulose** D) Polystyrene 3. Polyethylene is produced by: A) Condensation polymerization B) **Addition polymerization** C) Hydrolysis D) Oxidation 4. Benzoyl peroxide is commonly used as: A) Plasticizer B) Solvent C) **Initiator** D) Stabilizer 5. Nylon-6,6 is produced by the reaction between: A) Ethylene and propylene B) **Hexamethylene diamine and adipic acid** C) Vinyl chloride and styrene D) Phenol and formaldehyde 6. Bakelite is obtained from: A) Ethylene and chlorine B) Styrene monomers C) **Phenol and formaldehyde** D) Terephthalic acid and ethylene glycol 7. Which polymer processing technique is commonly used for manufacturing plastic bottles? A) Compression moulding B) **Blow moulding** C) Calendaring D) Casting 8. Biodegradable polymers are: A) Resistant to decomposition B) **Decomposed by microorganisms under suitable conditions** C) Made only from petroleum D) Completely inert in nature

Course Category: **Major Elective Practical**

120235 Industrial Chemistry Lab 16 A (Elective Industrial Chemistry-1)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120235**	**Industrial Chemistry Lab 16 A (Elective Industrial Chemistry-1)**	2	60	4 h	25+25= 50

Course Objectives:	After completion of the practical course, students will be able to: 1. To understand the basic principles, mechanisms, and techniques involved in polymerization reactions and polymer synthesis. 2. To develop laboratory skills for preparation, purification, and characterization of different polymers using standard experimental methods. 3. To create awareness about industrial applications, environmental impact, recycling, and sustainable development in polymer science.	
Course Outcomes:	After successful completion of the course, students will be able to: 1. Perform laboratory synthesis of various polymers using addition and condensation polymerization techniques safely and accurately. 2. Analyze and characterize polymers using methods such as viscosity, solubility, density, and thermal property measurements. 3. Identify different polymerization methods, reaction conditions, and factors affecting polymer formation and quality. 4. Demonstrate awareness regarding biodegradable polymers, polymer recycling, green chemistry, and environmental issues associated with plastic materials.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Tutorial and Discussion	Difference Between Addition and Condensation Polymerization. Role of Initiators and Catalysts in Polymerization. Structure–Property Relationship in Polymers. Factors Affecting Polymerization Reactions. Comparison of Natural and Synthetic Polymers. Importance of Molecular Weight in Polymers. Applications of Polymers in Daily Life. Environmental Impact of Plastic Waste. Biodegradable and Green Polymers. Recycling and Reuse of Polymers. Recent Developments in Polymer Science.	1. Laboratory-Based Learning Students should perform: Preparation of nylon, bakelite, urea-formaldehyde resin Determination of viscosity and molecular weight of polymers 2. Experiential Learning Students learn by direct practical experience through: Preparation of biodegradable polymers 3. Problem-Based Learning Provide practical problems such as: “How can biodegradable polymers reduce plastic pollution?” “How can polymer properties be modified?” 4. Project-Based Learning Assign mini-projects such as: Comparative study of natural

Experiments	1. Preparation of Phenol–Formaldehyde Resin (Bakelite) 2. Preparation of Urea–Formaldehyde Resin 3. Preparation of Polystyrene by Free Radical Polymerization 4. Preparation of Polyvinyl Alcohol Slime 5. Emulsion Polymerization of Styrene or Vinyl Acetate 6. Preparation of Nylon 6,6 by Interfacial Polymerization 7. Determination of Acid Value of Polymer Resin 8. Determination of Saponification Value of Polymer-Based Material 9. Determination of Glass Transition Temperature (Tg) of Polymer 11. Preparation of Biodegradable Polymer Film (Starch-Based Plastic) 12. Study of Thermal Degradation of Polymer Samples 13. Identification of Common Plastics by Solubility and Burning Test 14. Preparation of Epoxy Resin Adhesive 15. Preparation of Polyurethane Foam.	and synthetic polymers 5. Industry-Oriented Learning Case studies from polymer and plastic industries Guest lectures by industrial experts 6. ICT-Enabled Teaching Polymer structure animations Videos of industrial polymer processing techniques 7. Collaborative Learning Students work in groups for: Seminar presentations Industrial case studies 8. Green Chemistry and Sustainability Approach Integrate concepts such as: Biodegradable polymers Recycling of plastics
Suggested Student Activities	1. Preparation and Demonstration of Polymer Samples 2. Industrial Survey and Sample Collection Activity 3. Mini Project on Biodegradable and Eco-Friendly Polymers 4. Poster Presentation	
References	1. Experiments in Polymer Science by J. M. G. Cowie and Valeria Arrighi, CRC Press / Taylor & Francis 2. Polymer Science Laboratory Manual by S. P. Malshe and P. S. Sonawane, Tech-Max Publications, Pune 3. Practical Polymer Chemistry by M. P. Stevens, Oxford University Press 4. Laboratory Manual of Polymer Science by V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, Wiley Eastern Ltd. 5. Experimental Plastics and Synthetic Resins by K. S. V. Srinivasan, New Age International Publishers 6. Polymer Chemistry: Laboratory Techniques and Experiments by R. B. Seymour and C. E. Carraher Jr., Marcel Dekker Inc. **Web resources:** 1. https://www.acs.org/education/resources/highschool/chemmatters/past-issues/archive-2014-2015/polymers.html 2. https://edu.rsc.org/experiments 3. https://ocw.mit.edu 4. https://nptel.ac.in	
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 10 Marks
- Exercise 2 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category: **Major- Elective (Theory)**

120236 Elective Chemistry-2 (Dyes and Paints)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120236**	**Elective Chemistry-2 (Dyes and Paints)**	2	30	2 Hrs	30+20=50

Course Objectives:	After completion of the course students will be able to: 1. To understand the chemistry, classification, manufacture, and applications of dyes, pigments, paints, and surface coatings. 2. To study the composition, properties, and industrial preparation methods of various dyes and paints used in textile, polymer, and coating industries. 3. To develop knowledge of color chemistry, paint formulation, drying mechanisms, and testing methods for dyes and paints.
Course Outcomes:	After successful completion of the course, students will be able to: 1. Classify and explain the preparation, properties, and applications of different types of dyes, pigments and paints. 2. Describe the role of constituents such as binders, solvents, pigments, additives, and dryers in paint formulations. 3. Explain industrial manufacturing processes and applications of dyes and paints in textile, polymer, construction, and coating industries. 4. Demonstrate awareness regarding environmental pollution, toxicity, waste management, and eco-friendly alternatives in dye and paint industries.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Introduction to Paints and Surface Coatings:** Introduction, definition and functions of paints. Classification of paints: Oil paints, Emulsion paints, Distempers, Cement paints, Enamel paints Constituents of paints and their functions: Pigments, Binders (vehicles), Solvents, Extenders (fillers), Driers and additives Properties of an ideal paint Surface preparation and pretreatment of substrates Defects in painted surfaces and their remedies	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the
Unit II	**Manufacture, Testing and Applications of Paints** Manufacturing process of paints: Mixing, Grinding, Tinting, Thinning Paint formulation and pigment volume concentration (PVC) Drying mechanisms of paints Testing of paints: Viscosity, Drying time, Gloss, Hardness, Adhesion, Coverage Corrosion and protective coatings Industrial applications of paints	7 Hrs	7 Marks	

Unit III	**Dyes: Classification, Properties and Synthesis** Introduction and classification of dyes Chromophores and auxochromes Colour and constitution theory Classification of dyes based on application: Acid dyes, Basic dyes, Direct dyes, Mordent dyes, developed dye, vat dyes, Disperse dyes, pigment dye and Sulphur dye. Dye intermediates. Acid dye and basic dye. Synthesis and properties of methyl orange dye, picric acid and cynin dye. Factors affecting dyeing performance	8 Hrs	8 Marks	relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit IV	**Dyeing Processes and Environmental Aspects** Principles of dyeing, dyeing methods: Batch dyeing, Continuous dyeing, semi-continuous dyeing. Dyeing of natural fibres: Cotton, Wool, Silk Dyeing of synthetic fibres: Nylon, Polyester, Acrylic fibres Natural dyes: Sources, Extraction, Applications Textile dyeing equipment and processes: Jigger machine, Winch machine, Jet dyeing machine, package dyeing machine. Major environmental Problems due to dyeing industry.	7 Hrs	7 Marks	
References:	1. Surface Coatings: Raw Materials and Their Usage – A. A. Tracton (CRC Press). 2. Paint Technology Handbook – Rodger Talbert (CRC Press). 3. Organic Chemistry of Synthetic Dyes – K. Venkataraman (Academic Press). 4. Textbook of Dyeing and Textile Chemistry – J. N. Chakraborty (Business Managers Books Club). 5. A Textbook of Colour Chemistry and Dyeing – V. A. Shenai (Sevak Publications). 6. Industrial Chemistry – B. K. Sharma (Goel Publishing House). 7. Chemistry of Dyes and Principles of Dyeing – V. A. Shenai (Sevak Publications). 8. Introduction to Textile Coloration – Roger H. Wardman (Wiley-Blackwell). 9. Paints, Pigments and Industrial Coatings – A. K. De and A. K. De (New Age International). 10. Industrial Chemistry – P. C. Jain and Monika Jain (Dhanpat Rai Publications). **Web resources:** 1. https://nptel.ac.in 2. https://www.acs.org 3. https://polymerdatabase.com 4. https://www.chemguide.co.uk			
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. Define paint and mention its functions. 2. What is pigment volume concentration (PVC)? 3. Define viscosity of paint. 4. Define dyes and give two examples. 5. What are auxochromes? 6. Define dyeing. 7. What are natural dyes? 8. Name two natural sources of dyes.			
	Answer in brief (At least 6) (3 Marks each) 1. What are pigments? State their role in paint formulation. 2. What is the difference between emulsion paint and enamel paint?			

	3. Classify paints and describe the characteristics, advantages and applications of oil paints, emulsion paints, enamel paints and cement paints. **4.** Discuss environmental pollution caused by dye industries and explain various methods used for dye effluent treatment and management. 5. What are chromophores discuss with suitable example? 6. Explain the classification of dyes based on their method of application. Discuss acid, basic, direct, reactive, vat and disperse dyes.
	Answer in Detail (At least 4) (6 Marks each) 1. Explain the composition of paints. Discuss the functions of pigments, binders, solvents, extenders and driers. 2. Describe the manufacturing process of paints with a neat flow chart indicating mixing, grinding, tinting, thinning and packaging steps. 3. Explain various quality control tests carried out on paints such as viscosity, drying time, gloss, hardness, adhesion and coverage. **4.** Discuss the theory of colour and constitution. Explain the role of chromophores and auxochromes in colour production with suitable examples. 5. Explain the principles of dyeing and discuss the dyeing processes used for cotton, wool, silk and synthetic fibres.
	MCQs for Internal Assessment (At least 4) 1. Which component of paint provides colour and opacity? A) Solvent B) Binder C) **Pigment** D) Drier 2. Emulsion paints are mainly based on: **A) Water** B) Benzene C) Kerosene D) Turpentine oil 3. Which test is used to measure the flow property of paint? A) Gloss test B) Adhesion test C) **Viscosity test** D) Hardness test 4. Protective coatings are mainly used to: A) Increase corrosion B) Improve conductivity C) **Prevent corrosion** D) Increase porosity 5. The azo group present in azo dyes is: A) –OH B) $–NH_2$ C) **–N=N–** D) –COOH 6. The colour-producing group in a dye molecule is called: A) Auxochrome B) **Chromophore** C) Catalyst D) Binder 7. Which of the following is a natural dye source? A) **Indigo plant** B) Benzene C) Toluene D) Acetone 8. Reactive dyes are most commonly used for dyeing: A) **Cotton** B) Glass C) Metals D) Ceramics

Course Category: **Major Elective Lab**

120237 Industrial Chemistry Lab 16B (Elective Industrial Chemistry-2)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120237**	**Industrial Chemistry Lab 16B (Elective Industrial Chemistry-2)**	2	60	4 h	25+25= 50

Course Objectives:	After completion of the practical course on students will be able to: 1. To understand the principles and laboratory techniques involved in the preparation, formulation, and analysis of dyes, paints, pigments, and varnishes. 2. To develop practical skills in synthesis, testing, and evaluation of dyes and paint materials using standard laboratory methods. 3. To study the physical and chemical properties of dyes and paints and correlate them with industrial applications and performance.
Course Outcomes:	After successful completion of the practical course, students will be able to: 1. Prepare simple dyes, pigments, paints, or varnishes using standard laboratory procedures safely and accurately. 2. Perform analysis and quality testing of dyes and paints such as viscosity, drying time, pH, adhesion, hiding power, and wash fastness. 3. Explain the role of different constituents such as binders, solvents, pigments, fillers, and additives in paint and dye formulations. 4. Interpret experimental observations and relate the properties of dyes and paints with their industrial and commercial applications.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	Aim and Principle of the Experiment. Classification of Dyes and Paints. Functions of Paint Constituents. Mechanism of Dyeing and Paint Formation. Selection of Raw Materials. Experimental Procedure and Precautions. Observation and Interpretation of Results. Industrial Applications. Environmental and Health Hazards. Eco-Friendly Alternatives	1. Laboratory-Based Learning: Preparation of azo dyes and natural dyes 2. Experiential Learning: Preparing paint formulations using different constituents Studying commercial paint and dye samples 3. Problem-Based Learning: "How can paint durability be improved?" "Why do dyes show poor fastness?" 4. Project-Based Learning: Preparation of eco-friendly paints Comparative study of commercial paint samples 5. Inquiry-Based Learning: Role of pigments and binders in paints Factors affecting drying time and adhesion 6. Industry-Oriented Learning: Industrial case studies 7. ICT-Enabled Teaching: Videos of industrial dyeing and paint manufacturing 8. Collaborative Learning: Paint preparation Seminar presentations 9. Green Chemistry and Sustainability Approach: Natural and biodegradable dyes Sustainable coating technologies Any other innovative pedagogy as applicable.
Experiments	1. Determination of viscosity of paint using a viscometer. 2. Measurement of drying time of paint films. 3. Determination of paint coverage and hiding power. 4. Preparation of oil paint or emulsion paint. 5. Determination of gloss and adhesion of paint films. 6. Synthesis of an azo dye (e.g., methyl orange or orange II). 7. Synthesis of picric acid dye. 8. Dyeing of cotton fabric using direct dyes. 9. Dyeing of wool or silk using acid dyes. 10. Extraction of natural dyes from turmeric, marigold, or hibiscus. 11. Determination of wash fastness and light fastness of dyed fabrics.	
Suggested Skill-Based Activities	Preparation of Simple Dyes and Paints. Testing and Quality Control Activity Fabric Dyeing Demonstration Industrial Survey and Report Preparation Preparation of Poster or Chart Models Comparative Analysis of Commercial Paint Samples	

References	1. Practical Book of Paint and Varnish Technology by Aparesh Barman, Power Publishers 2. Experiments in Applied by Dr. Sunita Rattan, S. K. Kataria & Sons 3. Organic Lab Manual by Dr. Shailendra Kumar Sinha, Atlantic Publishers & distributors 4. A Laboratory Manual of polymers by S. M. Ashraf, Sharif Ahmad, Ufana Riaz, Techsar Pvt. Ltd. 5. Practicals in Polymer Science by Siddaramaiah, CBS Publishers & distributors. 6. Natural Dyeing Processes of India by B. C. Mohanty, K. V. Chandramouli, H. D. Naik, Calico Museum publications. **Web resources:** 1. https://textilelearner.net 2. https://nptel.ac.in 3. https://edu.rsc.org 4. https://www.chemguide.co.uk 5. https://www.paintsquare.com
Model Questions:	**NA**

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 10 Marks
- Exercise 2 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category: **Minor (Theory)**

120238 Minor Industrial Chemistry-3

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120238**	**Minor Industrial Chemistry-3**	2	30	2 Hrs	30+20=50

Course Objectives:	After studying this course, students will be able to: 1. Understand the principles, mechanisms, reagents, and industrial applications of important organic chemical processes such as nitration, amination by reduction, alkylation, and sulphonation. 2. Explain the manufacturing processes of industrially important chemicals including alkylbenzene and ethylbenzene, along with the factors affecting reaction efficiency and product quality. 3. Develop knowledge of process instrumentation used for measurement of temperature, pressure, and liquid level in chemical industries and understand their operating principles.
Course Outcomes:	Upon successful completion of the course, students will be able to: 1. Describe and explain the principles, mechanisms, reagents, operating conditions, and industrial significance of nitration, amination by reduction, alkylation, and sulphonation processes. 2. Analyze and illustrate the manufacturing processes of alkylbenzene and ethylbenzene, and evaluate the factors affecting sulphonation reactions in batch and continuous operations. 3. Identify, compare, and select suitable instruments for measurement of temperature, pressure, and liquid level in industrial process plants based on operating requirements. 4. Interpret the working principles and applications of thermometers, pyrometers, pressure gauges, manometers, liquid-level gauges, and other process measurement devices.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I	**A) Nitration:** Introduction, nitrating agents, nitration of Benzene to nitrobenzene and m-dinitrobenzene, Chlorobenzene to o and p-nitro-chloro benzenes. Continuous and batch nitration. **B) Amination by Reduction:** Introduction, methods of reduction, Bechamp Reduction (Iron and Acid Reduction), sulphide reduction, metal hydrides, cathodic reduction. Factors affecting amination. Manufacturing of aniline, m-nitroaniline. .	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning,
Unit-II	**A) Alkylation:** Introduction, alkylating agents, mechanism of alkylation. Manufacturing of alkylbenzene, ethylbenzene **B) Sulphonation:** Introduction, sulphonating agents, factors affecting sulphonation. Sulphonation of benzene, naphthalein. Batch and Continuous sulphonation.	7 Hrs	7 Marks	
Unit-III	**Process Equipments:** **A) Thermometer:** Glass, bimetallic, pressure spring, resistance and radiation pyrometer. **B) Pressure:** Manometer, barometer, pressure gauge, diaphragm, McLeod and Pirani gauge. **C) Liquid level:** Direct and indirect liquid level measurement, float type liquid level gauge, ultrasonic level gauge, and bell type liquid level gauge.	8 Hrs	8 Marks	
Unit-IV	**A) Corrosion:** Introduction, types of corrosion (galvanic, open air, underwater & underground). Mechanism of corrosion. Factors affecting corrosion. • Passivity: Introduction, chemical and mechanical passivity, oxide film • Theory of passivity.	7 Hrs	7 Marks	

	B) Methods adopted for preventing corrosion (metal coating processes): i) Galvanizations of iron (ii) Electroplating (iii) Painting (iv) Plastic coating			investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**

References	**1.** Dryden's Outlines of Chemical Technology by M. Gopala Rao and Marshall Sittig, East-West Press Pvt. Ltd. **2.** Shreve's Chemical Process Industries by George T. Austin and R. K. Sinnott, McGraw-Hill **3.** Chemical Process Technology by Jacob A. Moulijn, Michiel Makkee and Annelies E. van Diepen, Wiley **4.** Introduction to Chemical Engineering by S. K. Ghosal, S. K. Datta and S. Datta, Tata McGraw-Hill **5.** Process Instrumentation and Control Handbook edited by Douglas M. Considine, McGraw-Hill **6.** Handbook of Industrial Chemistry and Biotechnology edited by James A. Kent, Springer **7.** Corrosion Engineering by Mars G. Fontana, McGraw-Hill **8.** Principles and Prevention of Corrosion by Denny A. Jones, Pearson Education **9.** Industrial Instrumentation by Donald P. Eckman, Wiley Eastern. **Web resource:** 1. https://nptel.ac.in 2. https://www.learncheme.com 3. https://edu.rsc.org 4. https://www.asminternational.org 5. https://www.engineeringtoolbox.com 6. https://chemicalengineeringworld.com
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. What are the common sulphonating agents used in the sulphonation of aromatic compounds? 2. What is the function of a McLeod gauge? 3. Define Alkylation. 4. Define corrosion and mention any two factors affecting the rate of corrosion. 5. What are the commonly used nitrating agents in aromatic nitration?
	Answer in brief (At least 6) (3 Marks each) 1. What is the principle of operation of a bimetallic thermometer? 2. What is the principle of an ultrasonic level gauge? **3.** Why is concentrated sulphuric acid used along with nitric acid in nitration reactions? 4. Discuss the alkylating agents used for alkylation reaction. 5. Discuss direct and indirect methods of liquid-level measurement. Explain the construction and working of float-type liquid-level gauges. 6. Explain the electrochemical theory of corrosion. Discuss galvanization methods used for corrosion prevention in chemical industries.
	Answer in Detail (At least 4) (6 Marks each) 1. Explain the industrial manufacture of ethylbenzene. 2. Describe the construction, working principle, advantages, limitations, and industrial applications of resistance thermometers and radiation pyrometers. 3. Explain the construction and working of Bourdon pressure gauge. Discuss its advantages and industrial applications. 4. Explain the manufacture of nitrobenzene from benzene with flow diagram. 5. Describe the nitration of chlorobenzene to o-nitro-chlorobenzene and p-nitro-chlorobenzene with diagram. 6. Explain Bechamp reduction methods of reduction used for amination of nitro compounds, including. 7. Describe the industrial manufacture of aniline from nitrobenzene with flow diagram. 8. Explain the sulphonation of benzene with flow diagram.

	MCQs for Internal Assessment (At least 4) 1. Which of the following is commonly used as a nitrating agent in aromatic nitration? (A) Sulphuric acid (B) **Nitric acid and sulphuric acid mixture** (C) Hydrochloric acid (D) Acetic acid 2. Which instrument is most suitable for measuring very high temperatures without direct contact? (A) Glass thermometer (B) Bimetallic thermometer (C) **Radiation pyrometer** (D) Resistance thermometer 3. The McLeod gauge is mainly used for measuring: (A) Atmospheric pressure (B) High pressure (C) **Vacuum pressure** (D) Hydraulic pressure 4. In an ultrasonic level gauge, liquid level is determined by measuring: (A) Density (B) Viscosity (C) **Time taken by ultrasonic waves to return** (D) Pressure difference 5. Rusting of iron is an example of: (A) Physical change (B) **Electrochemical corrosion** (C) Polymerization (D) Sulphonation 6. Mixed acid used for nitration generally consists of: (A) $HCl + H_2SO_4$ (B) **$HNO_3 + H_2SO_4$** (C) $HNO_3 + HCl$ (D) $H_2SO_4 + CH_3COOH$ 7. Bechamp reduction employs: (A) Zinc and alkali (B) **Iron and acid** (C) Sodium borohydride (D) Lithium aluminium hydride 8. Nitrobenzene is reduced to: (A) Benzaldehyde (B) Phenol (C) **Aniline** (D) Benzoic acid 9. Oleum is widely used as a: (A) Nitrating agent (B) Oxidizing agent (C) **Sulphonating agent** (D) Reducing agent

Course Category: **Minor Lab**

120239 Minor Industrial Chemistry Lab 17

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120239**	**Minor Industrial Chemistry Lab 17**	2	60	4 h	25+25= 50

Course Objectives:	After completion of the practical course students will be able to: 1. To understand the principles, reaction mechanisms, and laboratory techniques involved in nitration, sulphonation, and corrosion processes. 2. To develop practical skills for carrying out organic synthesis reactions and corrosion studies using standard laboratory methods and safety practices. 3. To study the factors affecting nitration, sulphonation, and corrosion and analyze their industrial significance and applications.
Course Outcomes:	After successful completion of the practical course, students will be able to: 1. Perform nitration and sulphonation reactions safely and accurately using suitable reagents and experimental conditions. 2. Explain the reaction mechanisms, orientation effects, and factors influencing electrophilic substitution reactions such as nitration and sulphonation. 3. Conduct corrosion experiments, evaluate corrosion rates, and analyze the effect of environmental factors on metallic corrosion. 4. Demonstrate knowledge of corrosion prevention and control methods such as galvanization, coating, cathodic protection, and inhibitors.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	1. Principle and mechanism of sulphonation 2. Role of concentrated sulphuric acid and oleum 3. Importance of temperature control 4. Effect of acid concentration 5. Importance of recrystallization 6. Selection of suitable solvents 7. Dry and wet corrosion 8. Galvanic corrosion 9. Factors Affecting Corrosion	**1.Laboratory-Based Learning** Students should perform hands-on experiments such as: • Nitration of aromatic compounds • Sulphonation reactions • Corrosion studies on metals **2.Experiential Learning** • Observing corrosion in different environmental conditions • Comparing corrosion resistance of metals • Studying industrial applications of nitrated and sulphonated products **3.Problem-Based Learning** • "Why does corrosion occur faster in coastal areas?" • "How can corrosion losses be minimized?" • "What factors affect nitration yield?" **4.Project-Based Learning** Assign mini-projects such as: • Comparative corrosion study of different metals • **5.Inquiry-Based Learning**
Experiments	1. To prepare nitrobenzene by nitration of benzene using a nitrating mixture of concentrated nitric acid and sulphuric acid. 2. To synthesize m-dinitrobenzene by nitration of nitrobenzene and study the meta-directing effect of the nitro group. 3. To prepare o-nitro-chlorobenzene and p-nitro-chlorobenzene by nitration of chlorobenzene. 4. To prepare aniline from nitrobenzene using iron filings and hydrochloric acid. 5. Reduction of nitrobenzene to aniline using sodium sulphide as a reducing agent. 6. To prepare m-nitroaniline through reduction of m-dinitrobenzene. 7. To prepare benzene sulphonic acid by sulphonation of benzene using concentrated sulphuric acid. 8. To prepare naphthalene sulphonic acid and study the formation of α- and β-isomers. 9. To compare the sulphonating efficiency of concentrated sulphuric acid and oleum. 10. To measure fluid pressure using a U-tube manometer and verify the manometric equation. 11. To investigate the effect of environmental conditions on the corrosion of iron. 12. To determine the corrosion rate of a metal specimen by measuring weight loss over a specified period.	

	13. To study the effectiveness of paint, grease, and metallic coatings in preventing corrosion. 14. To compare the corrosion behavior of iron, copper, aluminum, and galvanized steel in different environments.	• Effect of temperature and concentration on nitration • Efficiency of protective coatings and inhibitors **6.Industry-Oriented Learning** • Industrial case studies on corrosion failures **7.ICT-Enabled Teaching** • Corrosion simulation software **8.Collaborative Learning** • Conducting corrosion experiments • Seminar presentations and discussions
Suggested Student Activities	1. Laboratory Preparations. 2. Determination of corrosion rate of different metals using weight loss or electrochemical methods. 3. Mini Project on Corrosion Prevention. 4. Industrial Survey and Case Study. 5. Seminar and Group Discussion. 6. Model or Poster Preparation.	
References	1. Industrial Chemistry Laboratory Manual by B. K. Sharma, Goel Publishing House, Meerut 2. A Textbook of Chemical Technology (Laboratory and Industrial Practices) by S. D. Shukla and G. N. Pandey, Vikas Publishing House Pvt. Ltd., New Delhi 3. Laboratory Manual of Organic Chemistry by V. K. Ahluwalia, Narosa Publishing House, New Delhi 5. Chemical Engineering Laboratory Manual by K. A. Gavhane, Nirali Prakashan, Pune 6. Laboratory Manual for Instrumentation and Process Control by M. Arumugam, Anuradha Agencies Publishers 7. Experiments in Unit Operations and Process Control by S. K. Som and G. Biswas, Tata McGraw-Hill Education 8. Experimental Methods in Corrosion Science and Engineering by Robert G. Kelly, John R. Scully, David W. Shoesmith and Rudolph G. Buchheit, CRC Press 9. Corrosion Testing Made Easy by Vinod S. Agarwala, NACE International 10. Corrosion Engineering Laboratory Manual by R. Winston Revie, Wiley **Web resources:** 1. https://epgp.inflibnet.ac.in 2. https://ocw.mit.edu 3. https://www.aiche.org 4. https://chemicalengineeringworld.com	
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities — 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * — 10 Marks
- Submission of duly certified practical record — 05 Marks

Total — **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 — 10 Marks
- Exercise 2 — 10 Marks
- Viva-Voce (external) — 05 Marks

Total — **25 Marks**

Course Category: **Vocational Skill Course VSC**

120240 Industrial Chemistry Lab- 18 (Industrial Materials and Analysis Laboratory)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120240**	**Industrial Chemistry Lab-18 (Industrial Materials and Analysis Laboratory)**	2	60	4 Hrs	50

Course Objectives:	After completion of this laboratory course, students will be able to: 1. Develop practical skills in preparation, testing, and analysis of industrial chemical products such as paints, detergents, dyes, and polymers. 2. Understand the basic principles of material chemistry, wastewater treatment, and environmental monitoring through hands-on experiments. 3. Acquire laboratory skills related to measurement of pH, crystallization, adsorption, filtration, solubility testing, and quality evaluation of chemical products.
Course Outcomes:	After successful completion of the course, students will be able to: 1. Prepare and evaluate industrial chemical products including paints, pigments, detergents, natural dyes, and lime water using standard laboratory procedures. 2. Perform analytical experiments such as pH determination, solubility testing, foaming capacity measurement, and crystallization techniques accurately. 3. Demonstrate understanding of environmental chemistry concepts through wastewater analysis, heavy metal removal, and water filtration experiments. 4. Interpret experimental observations, record laboratory data systematically, and analyze results related to industrial chemical processes and material properties. 5. Apply basic problem-solving and vocational laboratory skills relevant to chemical industries, environmental monitoring, and small-scale chemical manufacturing.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	Preparation of Laboratory Observation Charts Identify plastics, metals, ceramics, and polymers based on properties. Model Making Poster Presentation Compare properties of natural and synthetic materials. Discuss industrial applications of polymers, paints, and ceramics. Survey nearby industrial or urban areas for pollution sources. Preparation of Pollution Awareness Posters	By combining hands-on experiments, discussions, and real-world applications, students will gain a comprehensive understanding of chemistry lab practices. A few suggested pedagogies are: • Students should be given suitable **pre- and post-lab** assignments and explanation revising the theoretical aspects of laboratory experiments prior to and after the conduct of each experiment. • **Hands-On Laboratory Sessions:** Provide regular hands-on laboratory sessions where students can directly apply theoretical knowledge to practical experiments. • **Demonstrations and Simulations:** Use virtual
Experiments	1. Preparation of Paints and Pigments 2. Determination of pH of Industrial Effluent. 3. Removal of Heavy Metals from Wastewater by Adsorption techniques. 4. Preparation of Detergent Powder. 5. Measurement of pH of Paint Samples. 6. Testing Solubility of Different Polymers. 7. Study of Drying Time of Paints. 8. Preparation of Natural Dyes from Flowers or Turmeric 9. Preparation of Simple Water Filter. 10. Preparation of Vinegar Dilution Solutions 11. Testing Foaming Capacity of Soaps and Detergents 12. Crystallization of Copper Sulphate 13. Preparation of Lime Water	

Suggested Group Activities	1. Compare commercial products with laboratory-prepared samples. 2. Conduct oral discussions and quizzes on industrial chemicals and pollution control. 3. Visit soap, detergent, paint, or pharmaceutical industries. **4.** Study ingredients and safety symbols on chemical products.	simulations for certain experiments to enhance accessibility and understanding
References	1. A Textbook of Engineering Chemistry by S. S. Dara & S. S. Umare, S. Chand Publishing 2. Engineering Chemistry with Experiments by Dr. Sunita Rattan, S.K. Kataria & Sons 3. Green Chemistry and Environment by V. K. Ahluwalia, IBS/Indian Books & Periodicals 4. Experiments in Applied Chemistry by Dr. Sunita Rattan, S.K. Kataria & Sons 5. Advanced Engineering Chemistry by M. R. Senapati, Firewall Media **Web Resources:** 1. https://nptel.ac.in/course.html 2. https://www.vlab.co.in 3. https://www.schandpublishing.com 4. https://www.aicte-india.org 5. https://ncert.nic.in 6. https://www.ictmumbai.edu.in	
Model Questions:	**NA**	

Distribution of Marks and the scheme of (VSC) Practical Examination is as follows:

Section I: Continuous Internal Assessment

- Continuous Assessment Tests (CAT) (At least three tests) * 15 Marks
- Submission of duly certified practical record 10 Marks

Total **25 Marks**

Section II: End Semester Examination (Internal only)

- Exercise 1 20 Marks
- Viva-Voce (internal) 05 Marks

Total **25 Marks**

Total (Section I And II) **50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Course Category: **Skill Enhancement Course SEC**

120241 Industrial Chemistry Lab- 19 (Process Operations and Analytical Skills Development))

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120241**	**Chemistry Lab- 19 (Process Operations and Analytical Skills Development)**	2	60	4 Hrs	50

Course Objectives:	The intended objectives are: 1. To train students in the accurate use of analytical techniques such as titrations, gravimetric analysis, and instrumental methods for quantitative and qualitative assessment of chemical substances. 2. To provide practical exposure to the synthesis and processing of industrially important chemicals such as soaps, detergents, dyes, and polymers. 3. To enable students to understand and apply fundamental principles of chemical engineering and process chemistry in small-scale industrial setups.	
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Demonstrate the ability to perform volumetric and gravimetric analyses accurately and interpret 2. results to assess the quality and composition of chemical substances. 3. Develop practical skills in synthesizing industrially important products such as soaps, detergents, dyes, and polymers, following standard manufacturing procedures. 4. Gain hands-on experience in the preparation, testing, and quality evaluation of industrial chemical products such as paints, pigments, lubricants, and cement.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Tutorial and Discussion	Principle of the Experiment Advantages and limitations of the method Calibration and Standardization Maintaining laboratory records and log books Proper use of pH meter, colorimeter, spectrophotometer, etc. Effect of temperature, pressure, catalyst, and time Mixing, heating, filtration, distillation, drying, etc. Factors affecting percentage yield Use of Eco-friendly solvents and catalysts	Following pedagogical approaches will be incorporated: • **Experiential Learning (Hands-on Laboratory Work)** a. Conduct guided experiments on the synthesis of industrially relevant compounds.

Exercise/ Experiments	**A. Analytical Chemistry & Quality Control** 1.Estimation of metal ions Ca^{2+} using complexometric titrations 2.Assay of active ingredients in paracetamol 3.Assay of aniline 4.Determination of available chlorine in bleaching powder by iodometric method) **B. Industrial Chemical Processes** 1.Preparation of urea-formaldehyde 2.Preparation of phenol-formaldehyde resin 3.Preparation of soap. 4.Preparation of biodiesel from vegetable oil via transesterification **C. Chemical Industries and Products** 1.Preparation and testing of synthetic detergents 2.Viscosity measurement of lubricants using Ostwald viscometer 3.Determination of Acid value of lubricating oil. 4.Determination of saponification value of vegetable oil 5.Determination of iodine value of oil.	• **Inquiry-Based Learning** a. Promote critical thinking by comparing conventional and green synthesis approaches. • **Collaborative Learning** Facilitate group-based experimental work to enhance teamwork and problem-solving skills. • **Assessment through Reflective Learning** a. Encourage students to maintain lab journals for recording observations and interpretations. b. Conduct oral presentations and report writing to develop
Activities	Students prepare and standardize acids, bases, and salts. Hands-on use of pH meter, conductivity meter, colorimeter, and spectrophotometer. Calibration of laboratory instruments using standard samples. Problem-Solving Sessions Poster or Chart Preparation Flow Sheet Preparation Model Preparation Industrial Case Studies	
References	1. Vogel's Textbook of Quantitative Chemical Analysis By: J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas 2. Laboratory Manual of Analytical Chemistry By: R.K. Mohapatra 3. Instrumental Methods of Analysis By: Willard, Merritt, Dean, Settle 4. Quality Control for Dummies By: Larry Webber, Michael Wallace 5. Laboratory Manual in Industrial Chemistry By: B.K. Sharma 6. Practical Industrial Chemistry By: R. Gopalan, D. Venkappayya, S. Nagarajan 7. Industrial Chemistry: A Manual for Practical Instruction By: W.L. Asbury 8. Experimental Industrial Chemistry By: J. Heitner and L.C. Currie 9. Quantitative Analysis: Laboratory Manual By: Daniel C. Harris 10. Practical Pharmaceutical Chemistry – Vol I By: A.H. Beckett and J.B. Stenlake 11. Laboratory Manual in Industrial Chemistry By: B.K. Sharma 12. Industrial Chemistry: Laboratory Manual By: K.H. Davis and F.S. Berner **Web source:** 1. https://ocw.mit.edu/courses/chemistry/5-310-laboratory-chemistry-spring-2003/labs/ 2. https://labmonk.com/analytical-chemistry-experiments 3. https://nptel.ac.in/courses/103103209	
Model questions	NA	

Distribution of Marks and the scheme of (SEC) Practical Examination is as follows:

Section I: Continuous Internal Assessment

- Continuous Assessment Tests (CAT) (At least three tests) * 15 Marks
- Submission of duly certified practical record 10 Marks

Total **25 Marks**

Section II: End Semester Examination (Internal only)

- Exercise 1 20 Marks
- Viva-Voce (internal) 05 Marks

Total **25 Marks**

Total (Section I And II) **50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Course Category: **FP/CES**

120242 Industrial Chemistry Lab- 20 (FP/ CES in Industrial Chemistry - III)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	**120242**	**Chemistry Lab- 20 (FP/ CES in Chemistry - III)**	2	60	--	50

Course Objectives:	The intended objectives are: • To develop an appreciation of rural culture, lifestyle and wisdom amongst students. • To learn about the status of various agricultural and development programmes. • To understand the causes of distress and poverty faced by vulnerable households and explore solutions for the same. • To apply classroom knowledge of courses to field realities and thereby improve the quality of learning.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Gain an understanding of rural life, Indian culture and ethos and social realities 2. Develop a sense of empathy and bonds of mutuality with the local community 3. Appreciate significant contributions of local communities to Indian society and Economy 4. Learn to value the local knowledge and wisdom of the community 5. Identify opportunities for contributing to community's socio-economic improvements

Guidelines/ SoP for FP/CEP

For understanding key principles of CE, forms of CE, operational guidelines and implementation strategy please refer https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf

As per NEP 2020, students of B Sc. III of Semester V need to perform a Field Project (FP) for TWO (2) credits i.e. 50 Marks. The guidelines regarding the field project are as follows:

1) The total time allocation for the student to carry out field project is 60 hours.
2) Students should participate in field-based projects under the supervision of faculty.
3) Assignment of project topics to individual students or groups of students (max 4 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
4) For a SURVEY based project related questionnaire (15 or more questions) should be prepared.
5) The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
6) If the project is related to work that does not involve survey work, then the questionnaire part can be replaced accordingly (e.g. Sample collection/Data collection/ Experimental base etc).
7) The student should compile all the relevant data and carry out its analysis.
8) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc.
9) The project report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.). Submit the project report with the Guide's signature to the department.
10) The oral /poster presentation for all the projects should be arranged in the department. To evaluate the project, examiner should be appointed by HoD.
11) The total project work including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

Some suggested forms of FP/ CEP are:

1. **Linking learning with community service:** For example, students of chemistry can conduct water and soil testing in local areas and share the results with the local community.
2. **Linking research with community knowledge:** Community-based Participatory Research (CBPR) approaches are gaining recognition in this regard. For example, students of chemistry can undertake research in partnership with the community on solid and liquid waste disposal.
3. **Knowledge sharing and knowledge mobilization:** These can take the forms of enumerations, surveys, awareness camps and campaigns, training, learning manuals/films, maps, study reports, public hearings, policy briefs, cleanliness and hygiene teachings, legal aid clinics, etc. For example, students can undertake a 'swachhta survekshana' and/or nutrition survey for mothers and children, and educate them about hygiene and nutrition.
4. **Social innovations by students:** The students can be encouraged to initiate learning projects with a social impact and supported by HEIs. Incubation of such social innovation projects by students can also have meaningful links to existing curriculum and courses.

A few suggested (not exclusive) areas which not only provide practical applications of chemistry concepts but also foster collaboration, education, and sustainable practices within the community. are:

1. Understanding the chemical footprints of household products such as toothpaste, haircare, facecare food products etc
2. Enhance science literacy among school students through interactive chemistry demonstrations.
3. Managing organic waste to composting and improve soil health.
4. Explore the extraction and application of natural dyes as alternatives to synthetic dyes.

5. Identify and mitigate lead exposure risks in the community. 6. Implement a community-wide recycling initiative focusing on chemical waste and recyclable materials. 7. Introduce and demonstrate the principles of renewable energy sources, such as biofuels or solar energy. 8. Assess local air quality and raise awareness about pollution sources and mitigation strategies. 9. Educate community members on the safe use, storage, and disposal of household chemicals. 10. Assist local farmers in understanding soil nutrient content and composition to optimize crop production. 11. Evaluate local water sources for contaminants such as heavy metals, nitrates, and pH levels.	
References	1. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 2. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program 3. https://www.immerse.education/study-tips/100-ideas-for-research-projects-in-chemistry/ 4. https://pubs.rsc.org/en/content/articlelanding/2021/rp/d0rp00374c 5. https://www.acs.org/education/student-communities/activities.html 6. https://www.nettercenter.upenn.edu/academically-based-community-service-chemistry-outreach
Model Questions:	**NA**

Distribution of Marks and the scheme of FP/CEP Examination is as follows:

- Students' performance 20 Marks
- Submission of duly certified FP/CEP report 20 Marks
- Presentation (PPT or Poster) 10 Marks

Total **50 Marks**

Course Category: **Non Credit**

Foundation of Artificial Intelligence

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V		**Foundation of Artificial Intelligence**	Non credit	30	2 Hrs	30+20=50

Introduction :

The National Education Policy (NEP) 2020 emphasizes the integration of Artificial Intelligence (AI) across all undergraduate levels and disciplines to foster digital literacy and problem-solving skills. 'It can enhance the employability of the youth and prepare professionals in cutting-edge areas.'(pg. 46, R.D Kulkarni Report)

The Foundations of Artificial Intelligence course offers an overview of the key concepts, structures, applications, and ethical aspects of AI. It helps learners understand how intelligent systems work and shape modern life. The course covers AI's definition, evolution, types, and practical uses, along with its basic architectures like rule-based systems, machine learning, and neural networks. Learners will explore AI's role in education, healthcare, and commerce while reflecting on ethical and social concerns such as privacy, bias, and automation. In line with NEP 2020, it fosters digital literacy and responsible AI awareness for all disciplines.

A) Objective

i) Introduce all undergraduate students of all the faculties to the basic concepts, uses, and importance of AI.

ii) Enable learners to understand AI's principles, applications, limitations, and effectively use AI tools.

iii) Encourage students to recognize AI's role in enhancing life and engage with its social and ethical implications.

B) Outcomes

i) Understand the fundamental concepts, types, and evolution of Artificial Intelligence.

ii) Apply basic AI techniques and tools to real-world problems across different domains.

iv) Evaluate the social, ethical, and professional implications of AI in everyday life.

C) Implementation of Syllabus, Scheme of Examination and Teaching.

1) Curriculum, Teaching and Examination Scheme Given in Appendix A

2) This course given in Appendix A shall be compulsory course in **fifth semester** of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati.

2) Medium of instruction, paper setting and writing of Answer paper shall be in English, Marathi and Hindi.

3) Question paper shall be set and valuated by the College/ Department.

4) Duration of external examination shall be of 2 hours and paper shall be of 30 marks.

5) Internal 20 marks shall be distributed, 5 to attendance, 15 marks to assignment/class test/viva voce/presentation.

6) Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions.

7) It shall be obligatory on part of the college/department to conduct examination on prescribed date by the university and submit the candidate wise information as follows on university portal on due date after valuation answer books.

Grade A -- mark secured 30 to 50,

Grade B -- 25 to 29,

Grade C -- 20 to 24,

FAIL 19 and below

8) The final Grade shall be determined by the combined performance in internal and external assessments. A student must secure a minimum of 30% in the internal assessment, 30% in the external assessment, and at least 40% overall to pass. Failure to meet any of these criteria will result in a grade of "Fail."

9) In case of failure, student need to appeared in backlog examination by paying prescribed fees.

10) Valuated answer book shall be kept in college custody for one academic year and random verification may be done by the University if required.

11) Result of final year of respective degree shall not be declared of an examination unless secured any of the grades out of A to C in Foundation of Artificial intelligence.
12) Grade secured by an examinee in examination of said course shall be shown on fifth and last semester marksheet.
13) The candidates shall have to pay Rs 150 /- in 5th semester to the college to meet out the expenses by the college on teaching of course, question paper setting and printing, paper valuation, providing answer sheet, and filling grade on University portal. In case of failure student need to pay Rs 20 /- for conduction of examination. There shall not have any facility of revaluation of answer book.
14) For teaching of the subject person having PG degree in any faculty with second class shall be considered eligible, provided priority shall be given to Ph.D., NET, SET, regular teacher.

15) **Format of question paper**
Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions with internal choice.
1a) Long or short answer questions based on unit number 1 having 8 marks

Or
1b) Long or short answer questions based on unit number 1 having 8 marks
2a) Long or short answer questions based on unit number 2 having 7 marks

Or
2b) Long or short answer questions based on unit number 2 having 7 marks
3a) Long or short answer questions based on unit number 3 having 8 marks

Or
3b) Long or short answer questions based on unit number 3 having 7 marks
4a) Long or short answer questions based on unit number 4 having 8 marks

Or
4b) Long or short answer questions based on unit number 4 having 8 marks

Program:				**Semester:**	**V**	
Course:	**Foundation of Artificial Intelligence**			**Code:**		
Teaching Scheme				**Evaluation Scheme**		
Level	**Lecture**	**Hours**	**Credit**	**Internal**	**External**	**Total**
5.5	2	2	2	20	30	50
Methods of Internal Assessment: 15 Marks to Class Tests, /Assignments/ Viva voce/ Presentation & 5 Marks to Attendance						
Course Objectives: To introduce AI concepts in a simple, real-life way with focus on understanding applications, ethics, and future opportunities.						
Course Outcomes: After completion of the course, the students will be able to:						

CO	**Course Outcomes**	**BT Level**
CO-1	Explain the basic concepts, history, and types of AI with real-life examples.	L1 – Knowledge, L2 – Understanding
CO-2	Describe AI structures and architectures using simple real-world analogies.	L2 – Understanding, L3 – Application
CO-3	Identify and analyze applications of AI in the area of arts, commerce, humanities, and daily life.	L3 – Application, L4 – Analysis
CO-4	Evaluate ethical, social issues and predict future opportunities of AI in their own fields.	L4 – Analysis, L5 – Evaluation

Unit 1: Introduction to Artificial Intelligence (8 Hours)

Definition of AI: What is Intelligence? Natural vs. Artificial, Simple definition of AI; History & Evolution of AI: From early computers to modern AI; Types of AI: Narrow AI vs. General AI vs. Super AI; AI in Everyday Life: Google Maps, E-commerce suggestions, Chatbots, Social Media feeds; Key Components: Data, Algorithms, Computing Power

Unit 2: AI Structures, Architectures & Techniques (7 Hours)

Basic Structure of an AI System; AI Architectures (Simplified): Rule Based System, Machine Learning, Neural Networks; Key Concepts: Knowledge Representation (using symbols, facts), Search & Problem Solving (maze example, finding shortest route), Natural Language Understanding (Google Translate, chatbots)

Unit 3: Applications of AI in Society (7 Hours)

AI in Different Fields: Education (Personalized learning apps, plagiarism checkers), Healthcare (Disease prediction, medical chatbots), Commerce (Fraud detection in banking, stock market predictions, customer support), Daily Life (Smart home devices, language translation, travel assistants); AI & Decision Making: Hiring, Loan Approval, Court Decisions; Advantages of AI, Limitations of AI

Unit 4: Ethical, Social & Future Aspects of AI (8 Hours)

Ethical Concerns in AI: Privacy issues (CCTV, online data), Bias & Fairness (AI preferring certain groups), Job Displacement (automation replacing humans); Responsible AI: Transparency, Accountability, Human oversight; Future Trends in AI: Self-driving cars, AI in governance, creative industries; AI and You (Career Perspective): Opportunities in Digital Marketing, Content Creation, Business Analytics, HR Tech, Creative Industries (non-programming roles)

Textbook:

Melanie Mitchell – *Artificial Intelligence: A Guide for Thinking Humans*

Reference Books:

1. Boden, Margaret A., *Artificial Intelligence*: A Very Short Introduction
2. Elaine Rich – *Artificial Intelligence* (3rd Edition)
3. Godbole, Achyut, *Artificial Intelligence* (आर्टिफिशियल इंटेलजन्स), Bookganga Publication.
4. Kulkarni, Dr Anand, आर्टिफिशियल इंटेलजन्सच्या वाटेवर, Sakal Media Pvt. Ltd.
5. Stuart Russell – *Human Compatible* (2019)
6. Thorpe, Josh, *AI for Students: Creative Hacks for Academic Success*, Promplty Books

Course Category: **Major (Theory)**

120243 Industrial Safety and Cost Estimation

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120243**	**Industrial Safety and Cost Estimation**	2	30	2 Hrs	30+20=50

Course Objectives:	After successful completion of this course, students will be able to: 1. Understand the principles of cost estimation, interest calculations, depreciation methods, and profitability analysis used in chemical and industrial processes. 2. Develop skills in economic evaluation of industrial projects through the application of financial and cost accounting concepts. 3. Learn the principles of sampling and error analysis and apply statistical methods for obtaining reliable analytical and industrial data.
Course Outcomes:	Upon completion of the course, students will be able to: 1. Calculate production costs, interest, depreciation, and profitability parameters for industrial and chemical manufacturing processes. 2. Apply different methods of economic evaluation to assess the feasibility and financial performance of industrial projects. 3. Explain the properties, production methods, storage requirements, and industrial applications of important industrial gases such as oxygen, nitrogen, hydrogen, carbon dioxide, and acetylene. 4. Perform representative sampling procedures and evaluate different types of errors encountered in chemical analysis and industrial quality control. 5. Analyze experimental and industrial data using appropriate statistical tools and recommend measures to improve accuracy, precision, safety, and process efficiency.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**A) Industrial gases:** Introduction, Manufacturing and uses of following industrial gases - Oxygen and nitrogen, carbon dioxide liquification of CO_2 (Dry Ice). **B) Safety:** Introduction, concern for chemical safety, hazards and their control in petrochemical industries, hazards in storage, handling and uses of chemicals.	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss
Unit II	**A) Cost Estimation:** Cash flow for industrial operations, cumulative cash position, factors affecting investment and production cost. **B) Interest:** Simple Interest, Ordinary and exact simple interest. Compound interest, nominal and effective compound interest	7 Hrs	7 Marks	
Unit III	**A) Depreciation:** Introduction, service life, salvage value, junk value. Methods for determination of depreciation: Straight line method, declining balance method, sum of years digits method. **B) Profitability, profitability evaluation:** Rate of return on investment and discounted cash flow method. Breakeven point.	8 Hrs	8 Marks	
Unit IV	**A) Sampling:** Introduction, Sampling procedures: Random (non-systemic) and Non-random (systematic) sampling. Sampling of bulk materials. Techniques of	7 Hrs	7 Marks	

	sampling solids, liquids, gases. Collecting and processing of data. **B) Errors:** Introduction, Types of errors: Determinate and Indeterminate error. Nature and origin of error. Accuracy, precision, deviation, mean average deviation, standard deviation, relative standard deviation and confidence limits.			real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**

References:

Text books:

1. Elements of Chemical Engineering by Mahajani, V. V. & Mokashi, S. M., Macmillan India Ltd.
2. Plant Design and Economics for Chemical Engineers by Peters, M. S., Timmerhaus, K. D. & West, R. E., McGraw-Hill Education.
3. Industrial Chemistry by Jain, S. P. & Narang, K. L., Kalyani Publishers.
4. Outlines of Chemical Technology by Dryden, C. E., East-West Press.
5. Industrial Chemistry by Sharma, B. K., Goel Publishing House.
6. Industrial Engineering and Management by Khanna, O. P. Dhanpat Rai Publications.

Reference Books:

1. Contemporary Engineering Economics by Park, C. S., Pearson Education.
2. Engineering Economy by Blank, L. T. & Tarquin, A. J., McGraw-Hill.
3. Analysis, Synthesis and Design of Chemical Processes by Turton, R., Bailie, R. C., Whiting, W. B. & Shaeiwitz, J. A., Pearson.
4. Chemical Process Safety: Fundamentals with Applications by Crowl, D. A. & Louvar, J. F., Pearson.
5. An Introduction to Error Analysis by Taylor, J. R., University Science Books.
6. Lange's Handbook of Chemistry by Dean, J. A., McGraw-Hill.

Web Resources:

1. https://nptel.ac.in
2. https://www.cdc.gov/niosh
3. https://www.engineeringtoolbox.com
4. https://www.aiche.org
5. https://www.ilo.org/global/topics/safety-and-health-at-work

Model Questions:

Short Type (At least 6) (1 Marks each)

1. Define simple interest.
2. What is compound interest?
3. What is depreciation?
4. Define profitability.
5. Define sampling.
6. Define error.
7. Define accuracy.
8. Define Precision

Answer in brief (At least 6) (3 Marks each)

1. State one industrial application of oxygen.
2. State one industrial application of nitrogen gas.
3. Differentiate between fixed manufacturing cost?
4. Discuss cumulative cash position
5. Explain the methods of sampling of solid.
6. Explain the methods of sampling of liquid.

Answer in Detail (At least 4) (6 Marks each)

1. Discuss cash flow in Industry
2. Explain the factors affecting cost and investment
3. Derive the expression for exact and nominal simple interest.
4. Discuss various methods used for profitability analysis in industrial projects.
5. Describe the manufacture, properties, and applications of oxygen and nitrogen.
6. Discuss the importance of industrial safety and accident prevention in chemical industries.
7. Discuss the types of errors.

MCQs for Internal Assessment (At least 4)

1. Which of the following is a fixed cost?
   (A) Raw material cost
   (B) Fuel cost
   (C) **Construction of building**
   (D) Power consumption
2. Cost estimation is primarily used for:
   (A) Product advertising
   (B) **Project planning and economic evaluation**
   (C) Quality control
   (D) Inventory storage
3. Simple interest is calculated on:
   (A) Principal amount only
   (B) **Principal and accumulated interest**
   (C) Profit only
   (D) Depreciated value
4. Depreciation accounts for:
   (A) Increase in asset value
   (B) **Decrease in value of an asset over time**
   (C) Profit generation
   (D) Tax collection
5. Which method assumes equal depreciation every year?
   (A) Sinking fund method
   (B) **Straight-line method**
   (C) Declining balance method
   (D) Sum of years digit method
6. Oxygen and nitrogen are commercially produced by:
   (A) Electrolysis of water
   (B) **Fractional distillation of liquid air**
   (C) Contact process
   (D) Haber process
7. Which fire extinguisher is commonly used for electrical fires?
   (A) Water extinguisher
   (B) Foam extinguisher
   (C) **CO_2 extinguisher**
   (D) Sand bucket only
8. Which type of error can often be corrected by calibration?
   (A) Random error
   (B) Gross error
   (C) **Systematic error**
   (D) Sampling error

Course Category: **Major (Theory)**

120244 Chromatography

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120244**	**Chromatography**	2	30	2 Hrs	30+20=50

Course Objectives:	1. To introduce the fundamental principles and classification of chromatographic techniques. 2. To develop understanding of the instrumentation and operational procedures used in different chromatographic methods. 3. To study the separation, identification, and quantitative estimation of chemical substances using chromatography.
Course Outcomes:	After completion of the course, students will be able to: 1. Explain the principles and types of chromatographic techniques such as paper HPLC, GLC, column chromatography etc. 2. Perform qualitative and quantitative analysis using chromatographic methods and interpret chromatograms. 3. Apply chromatographic techniques for separation and analysis of mixtures in industrial, environmental, pharmaceutical, and research laboratories.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**General Introduction to chromatography:** Theories of chromatography, classification of chromatographic techniques. **A) Paper chromatography:** Introduction, principles, types of migration parameter (Rf value). Experimental details, applications. **B) TLC:** Introduction, principles, types of migration parameter (Rf value). Experimental details, applications.	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based**
Unit II	**A) GLC:** Introduction, principles, instrumentation: Sample injection port, column, Mobile phase or carrier gas system, stationary phase, detector. Procedural Steps: Sample injection and vaporization, Separation, Detection, data analysis. Factors affecting GLC. Column efficiency and selectivity, applications, advantages and limitations of GLC. **B) HPLC:** Introduction, principles, instrumentation: Solvent Reservoir, HPLC pump, Solvent Degasser, Solvent injector, HPLC column and column oven, Detector, Data system, Types: Normal phase HPLC, Reverse phase HPLC. Procedural steps: Sample preparation, mobile phase preparation, column selection, sample injection, separation of components, detection, data analysis. Factors affecting HPLC. Column efficiency. Applications, advantages and limitations	7 Hrs	7 Marks	

Unit III	**A) Ion Exchange:** Introduction, Classification of ion exchangers: Cation exchangers, anion exchangers. Instrumentation: Pump, Injector, columns, suppressor, detectors, data analysis. Procedural steps involved. Ion exchange equilibria, ion exchange capacity, chelating ion exchanger, factors affecting the separation of ions, advantages and	8 Hrs	8 Marks	**Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit IV	**Solvent Extraction:** Introduction, Nernst distribution law, Classification of solvent extraction systems: a) Chelate extraction b) Extraction by solvation c) Extraction involving ion pair formation d) Synergic extraction. Methods of extraction: Batch, continuous and counter current extraction. Basic principles involved in extraction. Factors affecting extraction efficiency: choice of solvent, acidity of aqueous phase, stripping, use of masking agent, back washing. Applications of solvent extraction in industries.	7 Hrs	7 Marks	
References:	1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House 2. Instrumental Methods of Analysis by H. Kaur, Pragati Prakashan 3. Analytical Chemistry by B. K. Sharma, Krishna Prakashan Media 4. Separation Techniques and Chromatography by R. P. W. Scott, CRC Press 5. Instrumental Analysis by Willard, Merritt, Dean & Settle, CBS Publishers & Distributors **Web Resources:** 1. https://nptel.ac.in/course.html 2. https://www.vlab.co.in 3. https://ocw.mit.edu 4. https://www.waters.com			
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. Define chromatography. 2. What is meant by stationary phase? 3. Define mobile phase in chromatography. 4. What is Rf value in paper chromatography? 5. State any two applications of TLC. 6. What is meant by elution? 7. Name the carrier gas used in GLC. 8. What is solvent extraction? 9. State any two advantages of HPLC.			
	Answer in brief (At least 6) (3 Marks each) 1. Explain the principle of paper chromatography. 2. Describe the procedure of thin layer chromatography. 3. Write a note on applications of GLC. 4. Explain the principle of ion exchange chromatography. 5. Describe solvent extraction with suitable example. 6. Explain factors affecting Rf values in chromatography. 7. Write the advantages and limitations of paper chromatography. 8. Explain the applications of ion exchange resins. **9.** Explain the significance of solvent selection in extraction techniques.			
	Answer in Detail (At least 4) (6 Marks each) 1. Explain the principle, procedure, applications, advantages, and limitations of paper chromatography. 2. Discuss thin layer chromatography in detail with principle, preparation of plates, procedure, applications, and advantages.			

	3. Describe the instrumentation and working of Gas Liquid Chromatography (GLC). Mention its applications in chemical industries. 4. Discuss ion exchange chromatography with suitable examples and industrial applications. 5. Explain the principle and mechanism of solvent extraction. Discuss factors affecting solvent extraction efficiency. 6. Discuss chromatographic separation techniques used in analytical chemistry and industrial analysis.
	MCQs for Internal Assessment (At least 4) 1. The stationary phase in paper chromatography is: a) Water b) **Paper** c) Solvent d) Silica gel 2. The value used to identify compounds in chromatography is: a) pH value b) **Rf value** c) Ksp value d) Viscosity 3. In TLC, the commonly used adsorbent is: a) Sodium chloride b) **Silica gel** c) Copper sulphate d) Charcoal 4. GLC is mainly used for separation of: a) Non-volatile compounds b) **Volatile compounds** c) Insoluble compounds d) Colloids 5. The mobile phase in HPLC is generally: a) Gas b) Solid c) **Liquid** d) Plasma 6. Ion exchange chromatography is based on: a) Size difference b) **Charge difference** c) Density difference d) Color difference 7. Solvent extraction is based on: a) Boiling point b) **Solubility difference** c) Density difference d) Conductivity 8. The detector commonly used in GLC is: a) UV detector b) **Flame ionization detector** c) Conductivity detector d) IR detector 9. Which chromatography technique uses a thin adsorbent layer coated on a plate? a) Paper chromatography b) **TLC** c) HPLC d) Ion exchange chromatography

Course Category: **Major (Theory)**

120245 Paper and Pulp

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120245**	**Paper and Pulp**	2	30	2 Hrs	30+20=50

Course Objectives:	1. Understand the history and significance of the paper industry. 2. Describe the basic steps involved in paper manufacture. 3. Describe paper manufacturing operations. 4. Understand quality control methods in paper industries.
Course Outcomes:	After completion of the course students will be able to: 1. Identify various raw materials used in paper production. 2. Understand pulp purification operations. 3. Explain the role of additives in paper production. 4. Evaluate physical properties of paper. 5. Identify environmental issues related to paper industries. 6. Explain wastewater treatment methods.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Introduction to Paper and Pulp Technology:** History and development of paper industry, Classification and grades of paper. Raw materials for pulp and paper manufacture: Wood, Bamboo, Bagasse, Straw, Waste paper Chemical composition of lignocellulosic materials: Cellulose, Hemicellulose, Lignin. Selection and preparation of raw materials. Storage and handling of raw materials. Overview of pulp and paper manufacturing process.	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to
Unit II	**Pulp Manufacturing Processes** Introduction to pulping. Mechanical pulping: Stone groundwood process, Refiner mechanical pulping Chemical pulping: Kraft (Sulphate) process, Sulphite process Semi-chemical pulping processes Digestion and recovery of chemicals Pulp washing and screening Comparison of mechanical and chemical pulping methods	7 Hrs	7 Marks	
Unit III	**Paper Manufacture, Finishing and Testing** Stock preparation and refining Additives used in paper manufacture: Fillers, Sizing agents, Retention aids, Dyes and pigments Sheet formation on paper machine Pressing, drying and calendaring Coating and finishing operations Properties and testing of paper: Grammage (GSM), Thickness, Tensile strength, Burst strength, Tear resistance Specialty papers and their applications	8 Hrs	8 Marks	
Unit IV	**Environmental Aspects and Recent Developments in Paper Industry**	7 Hrs	7 Marks	

	Sources of pollution in pulp and paper industries Characteristics of pulp and paper mill effluents Treatment of wastewater: Primary treatment, Secondary treatment, Tertiary treatment Solid waste management in paper mills Recycling and reuse of waste paper Cleaner production technologies and energy conservation Recent advances: Eco-friendly pulping, Bio-pulping, Nanocellulose and specialty paper products			apply theoretical knowledge. **Any other innovative pedagogy as applicable.**

References:

1. Pulp and Paper Technology – Monica Ek, Göran Gellerstedt & Gunnar Henriksson (Walter de Gruyter).
2. Handbook of Pulp and Paper Technology – Gary A. Smook (TAPPI Press).
3. Pulp and Paper Chemistry and Chemical Technology – James P. Casey (Wiley-Interscience).
4. Introduction to Pulp and Paper Technology – Raymond A. Young & Ludmila Akhtar (Wiley).
5. The Chemistry of Paper – J. C. Roberts (Royal Society of Chemistry).
6. Paper and Paperboard Packaging Technology – Mark J. Kirwan (Wiley-Blackwell).
7. Industrial Chemistry – B. K. Sharma (Goel Publishing House).
8. Industrial Chemistry – P. C. Jain & Monika Jain (Dhanpat Rai Publications).
9. Environmental Management in the Pulp and Paper Industry – Pratima Bajpai (Elsevier).
10. Biotechnology for Pulp and Paper Processing – Pratima Bajpai (Springer).

Web Resources:

1. https://www.tappi.org
2. https://www.valmet.com
3. https://www.andritz.com
4. https://www.fibre2fashion.com

Model Questions:

Short Type (At least 6) (1 Marks each)

1. Define pulp and paper.
2. Name any four raw materials used in paper manufacture.
3. What is cellulose?
4. Define pulping.
5. What is screening of pulp?
6. Define paper sizing.
7. Define burst strength of paper.

Answer in brief (At least 6) (3 Marks each)

1. Mention two specialty papers and their applications.
2. Mention two sources of pollution in paper mills.
3. What is primary wastewater treatment?
4. What is secondary wastewater treatment?
5. Discuss various raw materials used in the pulp and paper industry and explain their advantages and limitations.
6. Discuss the physical properties and quality control tests of paper such as GSM, thickness, tensile strength, burst strength and tear resistance.
7. What is GSM in paper testing? Explain.

Answer in Detail (At least 4) (6 Marks each)

1. Describe the chemical composition of lignocellulosic materials with special reference to cellulose, hemicellulose and lignin. Explain their significance in paper manufacture.
2. Explain the Kraft (Sulphate) pulping process with a neat flow diagram and discuss its advantages and disadvantages.
3. Compare mechanical, chemical and semi-chemical pulping processes with respect to principle, product quality, yield and applications.
4. Explain the various stages involved in paper manufacture, including stock preparation, sheet formation, pressing, drying and finishing.
5. Discuss the environmental problems associated with pulp and paper industries and explain various wastewater treatment methods used in paper mills.

MCQs for Internal Assessment (At least 4)

1. The principal constituent responsible for paper formation is:
   A) Lignin
   B) **Cellulose**
   C) Hemicellulose
   D) Resin
2. Which of the following is an agricultural residue used in paper manufacture?
   A) Coal
   B) **Bagasse**
   C) Limestone
   D) Gypsum
3. The most widely used chemical pulping process is:
   A) Groundwood process
   B) Sulphite process
   C) **Kraft process**
   D) Soda process
4. Mechanical pulping generally provides:
   A) Low yield
   B) **High yield**
   C) No fibre recovery
   D) No lignin content
5. GSM stands for:
   A) **Gram per Square Meter**
   B) Gram per Standard Meter
   C) General Sheet Measurement
   D) Grade Strength Measurement
6. Calendaring is carried out to:
   A) Increase moisture content
   B) **Improve smoothness and gloss**
   C) Increase lignin content
   D) Remove cellulose
7. Which treatment process mainly removes suspended solids from wastewater?
   A) **Primary treatment**
   B) Secondary treatment
   C) Tertiary treatment
   D) Biological treatment
8. Nanocellulose is mainly produced from:
   A) Coal
   B) Petroleum
   C) **Cellulose fibres**
   D) Limestone

Course Category: **Major Lab**

120246 Industrial Chemistry Lab 21

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120246**	**Industrial Chemistry Lab 21**	2	60	4 h	25+25= 50

Course Objectives:	1. Develop practical laboratory skills in separation, purification, analysis, and quality control techniques used in chemical and allied industries. 2. Acquire knowledge of safe handling of chemicals and industrial materials. 3. Apply analytical and industrial chemistry concepts for environmental monitoring, water treatment, and industrial process evaluation.
Course Outcomes:	Upon completion of the course students should able to 1. Perform laboratory experiments related to paper chromatography, TLC, ion exchange, solvent extraction, paper and pulp processing, and industrial safety using standard procedures. 2. Analyze experimental data and calculate errors, Rf values, partition coefficients, ion exchange capacity, and cost estimation parameters accurately. 3. Apply industrial safety measures, hazard identification, and proper chemical handling practices during laboratory work. 4. Develop problem-solving, teamwork, and vocational laboratory skills relevant to chemical, pharmaceutical, environmental, and paper industries.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	Principle of partition chromatography. Selection of stationary and mobile phases. Importance of solvent system in separation. Principle of adsorption chromatography. Preparation and activation of TLC plates. Choice of adsorbent and solvent system. Principle of ion exchange process. Structure and properties of ion exchange resins. Cation and anion exchange mechanisms. Principle of solvent extraction. Distribution law and partition coefficient. Selection of suitable extraction solvent. Factors affecting extraction efficiency.	By combining hands-on experiments, discussions, and real-world applications, students will gain a comprehensive understanding of chemistry lab practices. A few suggested pedagogies are: 1. Experiential and hands-on laboratory learning 2. Demonstration-based teaching for chromatographic techniques. 3. Problem-based learning through analytical calculations and data interpretation 4. Inquiry-based learning for experimental observations and result analysis 5. Collaborative learning through group experiments and discussions 6. ICT-enabled teaching using virtual labs, simulations, and graphing software 7. Project-based learning through sample analysis and mini-projects 8. Peer learning and seminar presentations on techniques of chromatography 9. Outcome-based continuous assessment through practical performance, assignments, viva voce, and laboratory reports
	1. Calculation of mean, median, and standard deviation of analytical data. 2. Separation of amino acids by paper chromatography. 3. Separation of plant pigments by paper chromatography. 4. Separation of Cu^{+2} and Ni^{+2} ions using paper chromatography. 5. Separation of methyl orange and methylene blue dye using paper chromatography. 6. Detection of sugars by paper chromatography. 7. Separation of amino acids using TLC. 8. Determination of ion exchange capacity of resin. 9. Purification of water by mixed bed ion exchange process. 10. Extraction of iodine from water using carbon tetrachloride/chloroform. 11. Extraction of caffeine from tea leaves. 12. Determination of moisture content in paper samples. 13. Determination of ash content in paper.	

References	1. Experiments in Applied Chemistry by Dr. Sunita Rattan, S.K. Kataria & Sons 2. Practical Engineering Chemistry by S. S. Dara & S. S. Umare, S. Chand Publishing 3. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House 4. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House 5. Industrial Chemistry Practical Manual by K. Mahalakshmi, MJP Publishers 6. Laboratory Manual in Industrial Chemistry by B. K. Sharma, Krishna Prakashan Media **Web Resources:** 1. https://www.vlab.co.in 2. https://nptel.ac.in/course.html 3. https://chem.libretexts.org 4. https://www.ictmumbai.edu.in 5. https://ncert.nic.in
Model Questions:	**NA**

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 (Inorganic Chem Practical) 10 Marks
- Exercise 2 (Physical Chem Practical) 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category: **Major- Elective (Theory)**

120247 Elective Industrial Chemistry-3 (Green Chemistry)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120247**	**Elective Chemistry-3 (Green Chemistry)**	2	30	2 Hrs	30+20=50

Course Objectives:	1. Assess environmental impacts of chemical processes. 2. Identify environmentally benign solvents and reagents. 3. Explain the role of catalysis in green synthesis. 4. Recognize applications of Green Chemistry in everyday life.
Course Outcomes:	After successful completion of the course, a student will be able to- 1. Explain the concept and significance of Green Chemistry. 2. Describe modern green technologies used in chemical industries. 3. Explain green synthetic routes and catalytic methods. 4. Explain sustainable waste management practices. 5. Evaluate the contribution of Green Chemistry to environmental protection and sustainable development.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Introduction to Green Chemistry and Principles:** Concept, scope and importance of Green Chemistry Environmental challenges associated with conventional chemical processes Sustainable development and chemistry Principles and Goals of Green Chemistry. Basic components of green chemistry: Alternative starting materials, alternative reagents and transformations, alternative reaction conditions, alternative final product or target molecule, optimization of framework for the design of greener synthetic pathway. Atom economy and reaction efficiency Prevention of waste and pollution at source Green metrics: Atom Economy, E-factor and Carbon Footprint	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative**
Unit II	**Green Solvents, Reagents and Alternative Technologies:** Hazards associated with conventional solvents Green solvents: Water as solvent, Supercritical fluids (Supercritical CO_2), Ionic liquids, Deep eutectic solvents Safer reagents and catalytic processes Microwave-assisted synthesis Ultrasound-assisted synthesis Photochemical and electrochemical methods Advantages and limitations of alternative technologies	7 Hrs	7 Marks	

Unit III	**Green Synthesis and Industrial Applications:** Green synthetic methodologies Catalysis in Green Chemistry: Homogeneous catalysis, Heterogeneous catalysis, Biocatalysis and enzymes Green oxidation and reduction reactions Solvent-free reactions Examples of green industrial processes: Green synthesis of adipic acid, Boots-Hoechst-Celanese (BHC) process for ibuprofen manufacture, Green production of polymers Renewable feedstocks and biomass utilization	8 Hrs	8 Marks	**pedagogy as applicable.**
Unit IV	**Green Chemistry in Daily Life and Environmental Applications:** Green chemistry approaches in agriculture: Biofertilizers, Biopesticides Green chemistry in pharmaceuticals Green household products and eco-friendly materials. Green fuels and E green Propellants. Waste minimization and recycling techniques Green nanotechnology and its environmental implications Role of Green Chemistry in climate change mitigation Future trends and opportunities in Green Chemistry	7 Hrs	7 Marks	
References:	1. Anastas, P.T. & Warner, J.C. – Green Chemistry: Theory and Practice. 2. Lancaster, M. – Green Chemistry: An Introductory Text. 3. Ahluwalia, V.K. – Green Chemistry: Environmentally Benign Reactions. 4. Matlack, A.S. – Introduction to Green Chemistry. 5. Clark, J.H. & Macquarrie, D.J. – Handbook of Green Chemistry and Technology. **Web Resources:** 1. https://nptel.ac.in/course.html 2. https://www.vlab.co.in 3. https://www.acs.org/greenchemistry.html 4. https://www.epa.gov/greenchemistry 5. https://www.epa.gov/greenchemistry			
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. Define Green Chemistry. 2. What is atom economy? 3. Why is water considered a green solvent? 4. What are ionic liquids? 5. Define bio-catalysis. 6. What are biofertilizers? 7. Define biopesticides.			
	Answer in brief (At least 6) (3 Marks each) 1. Differentiate between homogeneous and heterogeneous catalysis. 2. What are renewable feedstocks? **3.** What are biodegradable polymers?			

	4. Explain the Twelve Principles of Green Chemistry with suitable examples. 5. Describe solvent-free organic synthesis. Explain its advantages and applications in Green Chemistry. **6.** Explain waste minimization and recycling techniques used for environmental protection. 7. Explain waste minimization and recycling techniques used for environmental protection.
	Answer in Detail (At least 4) (6 Marks each) 1. Discuss the concept, objectives, scope and importance of Green Chemistry. Explain its role in sustainable development. 2. Discuss various green solvents used in Green Chemistry, including water, supercritical CO_2 and ionic liquids. 3. Describe the importance of catalysis in Green Chemistry. Discuss homogeneous, heterogeneous and bio-catalysis. 4. What are alternative energy sources in Green Chemistry? Explain photochemical and electrochemical methods in detail. 5. Explain green synthetic methodologies with suitable examples. 6. Discuss the role of catalysis in Green Chemistry and explain different types of catalytic processes. 7. Discuss the role of bio-catalysis and enzyme-catalyzed reactions in sustainable chemical synthesis. 8. Discuss the applications of Green Chemistry in agriculture with special reference to biofertilizers and biopesticides.
	MCQs for Internal Assessment (At least 4) 1. Green Chemistry primarily aims to: A) Increase chemical waste B) **Prevent pollution at the source** C) Increase use of hazardous chemicals D) Maximize energy consumption 2. Atom economy is a measure of: A) Reaction temperature B) Product purity C) **Utilization of reactant atoms in the desired product** D) Reaction rate 3. Which of the following is considered a green solvent? A) Benzene B) Carbon tetrachloride C) **Water** D) Chloroform 4. Supercritical carbon dioxide is widely used because it is: A) Toxic and expensive B) **Non-toxic and recyclable** C) Highly corrosive D) Radioactive 5. Biocatalysts are mainly: A) Metals B) Acids C) **Enzymes** D) Solvents 6. Which catalysis uses a catalyst in a different phase from the reactants? A) Homogeneous catalysis B) **Heterogeneous catalysis** C) Photocatalysis D) Electrocatalysis 7. The BHC process is associated with the green manufacture of: A) Aspirin B) **Ibuprofen** C) Paracetamol D) Penicillin

	8. Biofertilizers contain: A) Synthetic chemicals B) Radioactive substances C) **Beneficial microorganisms** D) Heavy metals 9. Which of the following is an eco-friendly pest control method? A) DDT application B) **Use of biopesticides** C) Excessive pesticide spraying D) Chemical fumigation only 10. Recycling helps to: A) Increase waste generation B) **Conserve natural resources** C) Increase pollution D) Decrease resource utilization

Course Category: **Major Elective Lab**

120248 Industrial Chemistry Lab 22A (Elective Industrial Chemistry 3)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120248**	**Industrial Chemistry Lab 22A (Elective Industrial Chemistry 3)**	2	60	4 h	25+25= 50

Course Objectives:	. 1. Develop practical skills in green synthesis, eco-friendly product preparation, waste minimization, and use of renewable resources. 2. Apply environmentally benign methods for chemical synthesis, extraction, purification, and pollution control. 3. Promote awareness of sustainable development, resource conservation, and environmentally responsible chemical technologies.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Perform green synthesis experiments using eco-friendly reagents, solvents, and energy-efficient methods. 2. Prepare biodegradable and environmentally safe products such as natural dyes, herbal cleaners, biodiesel, biodegradable plastics, and green nanoparticles. 3. Apply green chemistry principles for reduction of hazardous waste, pollution prevention, and sustainable laboratory practices. 4. Demonstrate practical skills in extraction, adsorption, recycling, biodegradation studies, and green analytical methods. 5. Develop problem-solving abilities, environmental awareness, and vocational skills relevant to sustainable chemical industries and research.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	1. Importance and objectives of green chemistry. 2. Need for sustainable chemical processes. 3. Environmental impact of conventional chemical methods. 4. Selection of eco-friendly solvents and reagents. 5. Advantages of solvent-free reactions. 6. Economic benefits of green technologies. 7. Green chemistry in small-scale industries and entrepreneurship.	1. Experiential and hands-on laboratory learning 2. Demonstration-based teaching for synthesis by green method 3. Problem-based learning through reaction mechanism 4. Inquiry-based learning by using various alternative starting materials for synthesis. 5. ICT-enabled teaching using

Experiments	1. Calculation of atom economy for selected reactions. 2. Solvent-free synthesis of organic compounds. 3. Microwave-assisted synthesis. 4. Preparation of biodiesel from vegetable oil. 5. Extraction of natural dyes using green solvents. 6. Comparative study of conventional and green cleaning agents. 7. Synthesis of nanoparticles using plant extracts (green synthesis). 8. Determination of E-factor for a simple laboratory process. 9. Preparation of biodegradable polymer films. 10. Composting and waste recycling demonstration. 11. Natural Dye Extraction from Flowers and Leaves 12. Preparation of esters using green catalysts. 13. Preparation of Starch-Based Bioplastic	visualization tools, and virtual labs 6. Collaborative learning through group experiments, discussions, and peer learning 7. Project-based learning through mini-projects on synthesis by green method 8. Flipped classroom approach for pre-lab study of reactions. 9. Outcome-based continuous assessment through laboratory performance, assignments, viva voce, and reports **10. Any other innovative pedagogy as applicable.**
Suggested Student Activities	1. Preparation of Eco-Friendly Products 2. Compare green synthesis methods with conventional chemical methods. 3. Poster Presentation on Green Chemistry 4. Study industrial pollution cases and green solutions. 5. Mini projects on herbal products, green fuels, or biodegradable materials.	
References	1. Green Chemistry Laboratory Manual for General Chemistry by James E. Hutchison, University of Oregon / Beyond benign. 2. Laboratory Experiments in Green and Sustainable Chemistry by Stanley E. Manahan, CRC Press 3. Green Chemistry Experiments for Undergraduate Laboratories by Kenneth M. Doxsee & James E. Hutchison, homson Brooks/Cole 4. Environmental Chemistry Manual by S. K. Banerji, Prentice-Hall of India (PHI) **5.** Green Chemistry for Environmental Sustainability by Vinod Kumar Ahluwalia, CRC Press / Apple Academic press **Web resources:** 1. https://nptel.ac.in/course.html 2. https://www.vlab.co.in 3. https://www.acs.org/greenchemistry.html 4. https://www.epa.gov/greenchemistry 5. https://www.epa.gov/greenchemistry	
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 10 Marks
- Exercise 2 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category: **Major- Elective (Theory)**

120249 Elective Industrial Chemistry-4 (Instrumentation Techniques)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120249**	**Elective Industrial Chemistry-4 (Instrumentation Techniques)**	2	30	2 Hrs	30+20=50

Course Objectives:	1. Understand the basic principles, working, and applications of modern analytical instruments used in chemical analysis. 2. Gain knowledge of qualitative and quantitative analysis using instrumental methods such as spectroscopy, chromatography, and electrochemical techniques. 3. Develop practical skills in operation, calibration, and maintenance of common analytical instruments.
Course Outcomes:	After successful completion of this course, students will be able to: 1. Explain the principles and working mechanisms of major analytical instruments used in chemical analysis. 2. Analyze chemical samples using instrumental techniques and interpret experimental data accurately. 3. Apply instrumental methods for qualitative and quantitative analysis of organic, inorganic, and environmental samples. 4. Select appropriate analytical techniques for specific chemical analysis problems in industry and research. 5. Develop problem-solving, analytical thinking, and technical skills required for laboratory and industrial careers.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Flame Photometry:** Introduction, principle, Elementary theory, instrumentation and experimental techniques: Source of flame, nebulizer, Mixing chamber, burner and flame, optical filter or monochromator, photo detector, amplifier. Working procedure. Applications, advantages and limitations.	7 Hrs	7 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. Ask students to create concept maps that illustrate the relationships between different concepts. **Inquiry-Based**
Unit II	**I.R. Spectroscopy:** Introduction, Basics of Infrared Spectroscopy: Electromagnetic spectrum, molecular vibrations. Principle and techniques. Instrumentation: Radiation source, sample compartment, monochromator or interferometer, detector, data processing and analysis. Applications in chemical analysis of industrial materials with respect to structural elucidation, functional group analysis, monitoring chemical reactions, polymer characterization and environmental analysis.	8 Hrs	8 Marks	

Unit III	**X-ray fluorescence:** Introduction, Principles, Instrumentation techniques: X-ray Source, Sample holder, Collimator, Crystal Monochromator, Detector, amplifier and data system flow sheet. Working of XRF, Types of XRF: Energy dispersive XRF, Wavelength Dispersive XRF. Industrial Applications, environmental applications, Advantages and limitations.	8 Hrs	8 Marks	**Learning:** Explore topics through questioning, investigation, and research. **Any other innovative pedagogy as applicable.**
Unit IV	**Column chromatography:** Introduction, Principle, Experimental details: Column, stationary phase, mobile phase, sample mixture. Procedure of column chromatography. Types of column chromatography, column efficiency, factors affecting column efficiency, applications. Advantages, Applications and limitations.	7 Hrs	7 Marks	
References:	1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal and Sham K. Anand, Himalaya Publishing House 2. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt Jr., J.A. Dean and F.A. Settle Jr., CBS Publishers / Wadsworth Publishing. 3. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler and Stanley R. Crouch, Cengage Learning 4. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F.J. Holler and Stanley R. Crouch, Cengage Learning 5. Analytical Chemistry: Principles by John H. Kennedy, Saunders College Publishing 6. Introduction to Instrumental Analysis by Robert D. Braun, McGraw-Hill 7. Infrared and Raman Spectroscopy: Principles and Spectral Interpretation by Peter Larkin, Elsevier **Web Resources:** 1. https://chem.libretexts.org 2. https://webbook.nist.gov/chemistry 3.https://www.thermofisher.com/in/en/home/industrial/spectroscopy-elemental-isotope-analysis.html 4. https://www.bruker.com 5. https://www.iaea.org/resources			
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. What is flame photometry? 2. Which type of elements are commonly analyzed by flame photometry? 3. Give two applications of flame photometry. 4. What is infrared spectroscopy? 5. Define stretching vibration. 6. Define bending vibration. 7. Give two applications of IR spectroscopy. 8. Name any two applications of XRF.			
	Answer in brief (At least 6) (3 Marks each) 1. State the basic principle of IR spectroscopy. 2. State the principle of flame photometry. 3. What is meant by molecular vibration? 4. Discuss molecular vibrations and explain stretching and bending vibrations with suitable examples. 5. Discuss the advantages, limitations and applications of XRF spectroscopy. 6. Describe the different regions of the infrared spectrum and their analytical significance. 7. Discuss the advantages, limitations, sources of error and applications of flame photometry			

	Answer in Detail (At least 4) (6 Marks each) 1. Explain the principle, instrumentation, working and applications of flame photometry with a neat labeled diagram. 2. Discuss the various components of a flame photometer and explain the function of each component. 3. Describe the processes of nebulization, atomization, excitation and emission involved in flame photometry. 4. Explain the principle, instrumentation and working of IR spectroscopy with a neat labeled diagram. 5. Describe the construction and working of FTIR spectrophotometer and discuss its advantages over conventional IR spectrometers. 6. Discuss the applications of IR spectroscopy in organic, inorganic and industrial chemistry. 7. Explain the principle, instrumentation and working of X-ray fluorescence spectroscopy with a neat labeled diagram. 8. Discuss the origin of characteristic X-rays and the phenomenon of X-ray fluorescence. Describe the components of an XRF spectrometer and explain the function of each component.
	MCQs for Internal Assessment (At least 4) 1. Flame photometry is based on the measurement of: (A) Absorption of light (B) **Emission of light by excited atoms** (C) Scattering of light (D) Reflection of light 2. Flame photometry is mainly used for the analysis of: (A) Non-metals (B) Transition metals **(C) Alkali and alkaline earth metals** (D) Noble gases 3. The device used to convert a liquid sample into a fine spray is called: (A) Burner (B) Detector **(C) Nebulizer** (D) Monochromator 4. The most commonly determined element by flame photometry is: **(A) Sodium** (B) Sulfur (C) Chlorine (D) Bromine 5. IR spectroscopy is based on: (A) Electronic transitions (B) **Molecular vibrations** (C) Nuclear transitions (D) Radioactive decay 6. The unit commonly used for IR spectra is: (A) Nanometer (B) Joule (C) **Wavenumber (cm^{-1})** (D) Kelvin 7. IR spectroscopy is mainly used for: (A) Determination of atomic weight (B) **Identification of functional groups** (C) Measurement of radioactivity (D) Determination of density 8. XRF stands for: (A) X-ray Frequency Analysis (B) **X-ray Fluorescence**

	(C) X-ray Formation (D) X-ray Fusion 9. XRF is mainly used for: (A) **Elemental analysis** (B) Protein analysis (C) pH measurement (D) Moisture determination 10. In XRF, atoms emit: (A) UV rays (B) Gamma rays (C) **Characteristic X-rays** (D) Infrared rays

Course Category: **Major Elective Lab**

120250 Industrial Chemistry Lab 22B (Elective Industrial Chemistry 4)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120250**	**Industrial Chemistry Lab 22B (Elective Industrial Chemistry 4)**	2	60	4 h	25+25= 50

Course Objectives:	1. Develop practical laboratory skills in qualitative and quantitative analysis using modern spectroscopic and chromatographic techniques. 2. Acquire knowledge of separation, purification, and identification methods used in chemical, pharmaceutical, environmental, and industrial laboratories. 3. Enhance problem-solving, analytical thinking, and scientific reporting skills through hands-on laboratory experiments.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Operate and perform experiments using flame photometer, IR spectrophotometer, and XRF instruments following standard laboratory procedures. 2. Perform separation and purification of chemical compounds using column chromatography, adsorption chromatography, and liquid–liquid partition chromatography. 3. Determine Rf values, partition coefficients, adsorption behavior, and concentration of analytes accurately from experimental observations. 4. Apply analytical techniques for quality control, environmental analysis, pharmaceutical testing, and industrial applications. 5. Develop vocational and technical skills relevant to analytical chemistry, industrial laboratories, and research applications.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	1. Importance of instrumental methods in modern chemical analysis 2. Calibration and standardization of instruments 3. Industrial applications of analytical instruments 4. Principle of separation based on partition/adsorption 5. Comparison between different chromatographic techniques	**Inquiry-Based Learning** Students are encouraged to ask "why" and "how" behind each experiment **Hands-on Laboratory Learning** Direct operation of instruments (flame photometer, IR spectrometer, XRF, chromatographic setups) **Project-Based Learning** Mini-projects like: Analysis of fertilizers, soil, or water samples **Collaborative/Group Learning** Students work in small groups for: Sample analysis and
Experiments	1. Determination of calcium ions using flame photometry. 2. Quantitative estimation of sodium in water sample using flame photometer. 3. Determination of potassium in fertilizer samples. 4. Separation of plant pigments by column chromatography. 5. Separation of dyes using adsorption column chromatography. 6. Separation of amino acids using column chromatography. 7. Separation of food colors using partition chromatography. 8. Separation of colored compounds using adsorption chromatography. 9. Study of adsorption of acetic acid on charcoal. 10. Decolorization of dye solutions using adsorption method 11. Separation of ink components by adsorption chromatography. 12. Separation of organic mixtures using adsorption column.	
Group Activities	1. Poster Presentation 2. Flow chart preparation 3. Preparation of TLC plates and separation of dyes 4. Instrument labeling and diagram drawing exercises 5. Project on "Separation of natural dyes using chromatography" 6. Industrial visit to analytical or testing laboratory	

References	1. Instrumental Methods of Chemical Analysis by V. K. Ahluwalia, Springer Nature 2. Fundamental Concepts of Analytical Chemistry by S. M. Khopkar,New Age International Publishers 3. Quantitative Chemical Analysis by Daniel C. Harris, W. H. Freeman and Company 4. Chromatography: Concepts and Contrasts by James M. Miller, Wiley India 5. Principles of Instrumental Analysiby Douglas A. Skoog, F. James Holler & Stanley Crouch, Cengage Learning

	Web Resources: 1. https://nptel.ac.in/course.html 2. https://www.vlab.co.in 3. https://chem.libretexts.org 4. https://www.acs.org 5. https://www.chromacademy.com
Model Questions:	**NA**

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities — 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * — 10 Marks
- Submission of duly certified practical record — 05 Marks

Total — **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 — 10 Marks
- Exercise 2 (Group activity) Presentation — 10 Marks
- Viva-Voce (external) — 05 Marks

Total — **25 Marks**

Course Category**: Minor (Theory)**

120251 Minor Industrial Chemistry-4

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120251**	**Minor Industrial Chemistry-4**	2	30	2 Hrs	30+20=50

Course Objectives:	1. Gain knowledge of industrial manufacturing processes of important chemicals, fertilizers, dyes, polymers, and fine chemicals. 2. Learn the role of catalysts, reaction conditions, and process parameters such as temperature, pressure, and concentration in industrial reactions. 3. Develop an understanding of process flow diagrams, unit operations, and equipment used in chemical industries.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Explain the principles and mechanisms of important unit processes 2. Describe industrial manufacturing processes of selected chemicals and relate them to reaction mechanisms and conditions. 3. Analyze the effect of process variables such as temperature, pressure, catalysts, and time on yield and product quality. 4. Interpret process flow diagrams and identify different unit operations in chemical industries. 5. Demonstrate awareness of industrial safety, pollution control, and environmental sustainability in chemical processes.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**A) Halogenation:** Introduction, halogenating agents, nuclear and side chain aromatic halogenation. Manufacturing of chlorobenzene, chloral, monochloro acetic acid. **B) Oxidation:** Introduction, various hydrolyzing agents, types of oxidative reactions, mechanism of oxidation, liquid and vapour phase oxidation. Manufacturing of benzoic acid, acetaldehyde and acetic acid.	8 Hrs	8 Marks	**Interactive Lectures:** Use multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model **Problem-Solving Sessions**: Organize regular problem-solving sessions. Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. **Any other innovative pedagogy as applicable.**
Unit II	**A) Hydrogenation:** Introduction, various catalysts used for hydrogenation, Manufacturing of methanol from carbon-monoxide and hydrogen, hydrogenation of vegetable oil. **B) Esterification:** Introduction, esterification of organic acids using unsaturated compounds. Manufacturing of ethyl acetate, vinyl acetate, cellulose acetate.	7 Hrs	7 Marks	
Unit III	Industrial solid waste and Treatment processes Introductions, types of solid wastes, methods of industrial solid waste treatment & disposal. i)Composting, ii) Sanitary Landfills, iii) Thermal process (Incineration & pyrolysis)	8 Hrs	8 Marks	
Unit IV	**Hazards waste:** Introduction to Industrial waste, Classification of Industrial waste with sources: Biomedical waste, Radioactive waste and Nonradioactive waste containing toxic and heavy metals. Methods of their disposal. Recycling & reuse.	7 Hrs	7 Marks	
References:	1. Perry's Chemical Engineers' Handbook by Perry and Green, McGraw Hill 2. Environmental Chemistry by A.K. De, New Age International Publishers 3. Unit Processes in Organic Synthesis by P.H. Groggins, McGraw Hill 4. Handbook of Industrial Chemistry by Kirk-Othmer, John Wiley & Sons			

	5. Hazardous Waste Management by LaGrega et al., Waveland Press 6. Environmental Biotechnology by Indu Shekhar Thakur, I.K. International Publishing House 7. Industrial Wastewater Treatment by Rao and Datta, Oxford & IBH Publishing 8. Organic Chemistry by Morrison and Boyd, Pearson Education 9. Advanced Organic Chemistry by Jerry March, John Wiley & Sons 10. Environmental Pollution and Control by Peirce et al., Butterworth-Heinemann **Web Resources** 1. https://www.epa.gov 2. https://cpcb.nic.in 3. https://nios.ac.in 4. https://chem.libretexts.org 5. https://www.chemguide.co.uk 6. https://www.britannica.com/science/industrial-chemistry 7. https://nptel.ac.in
Model Questions:	**Short Type (At least 6) (1 Marks each)** 1. What is halogenation? 2. What is hydrogenation? 3. Name one catalyst commonly used in hydrogenation reactions. 4. Define industrial solid waste. 5. What is hazardous waste? **6.** Give two examples of hazardous industrial waste. **7.** Give any two oxidizing agents.
	Answer in brief (At least 6) (3 Marks each) 1. Name any two methods used for treatment of industrial solid waste. 2. Explain the process of side chain halogenation. 3. Explain the process of nuclear halogenation. 4. Discuss the methods used for handling, treatment, and disposal of hazardous waste. 5. Explain the classification and characteristics of hazardous waste. 6. Describe the Hardening of vegetable oil by hydrogenation process.
	Answer in Detail (At least 4) (6 Marks each) 1. Explain the industrial process of hydrogenation with examples. 2. Explain various sources of industrial solid waste and their environmental impacts. 3. Describe different treatment and disposal methods of industrial solid waste. 4. Explain the manufacturing process of chlorobenzene with diagram. 5. Explain the manufacturing process of benzoic acid with diagram. 6. Explain the manufacturing process of ethyl acetate with diagram.
	MCQs for Internal Assessment (At least 4) 1. Which of the following is commonly used for chlorination? a) Oxygen b) **Chlorine** c) Nitrogen d) Hydrogen 2. Halogenation is mainly used to introduce: a) Oxygen atom b) Sulfur atom c) **Halogen atom** d) Nitrogen atom 3. Which gas is used in hydrogenation? a) Oxygen b) **Hydrogen** c) Nitrogen d) Chlorine 4. Nickel is mainly used as a: a) Solvent b) **Catalyst** c) Oxidizing agent d) Refrigerant

	5. Which of the following is a method of solid waste disposal? a) Filtration b) **Landfilling** c) Distillation d) Electrolysis 6. Composting is mainly used for: a) Radioactive waste b) Metallic waste c) **Biodegradable waste** d) Plastic waste **7.** Hazardous waste may be: a) Toxic b) Flammable c) Corrosive d) **All of these** 8. Incineration is commonly used for treatment of: a) Harmless waste b) **Hazardous waste** c) Domestic water d) Food products

Course Category**: Minor Lab**

120252 Minor Industrial Chemistry Lab- 23

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120252**	**Minor Industrial Chemistry Lab- 23**	2	60	4 h	25+25= 50

Course Objectives:	1. Understand the fundamental concepts of important industrial unit processes 2. Gain knowledge of industrial solid waste generation, classification, and treatment methods used in chemical and allied industries. 3. Develop awareness of hazardous waste types, their characteristics, safe handling, storage, transport, and disposal methods. 4. Apply principles of environmental protection and green chemistry in managing industrial waste and improving process sustainability.
Course Outcomes:	After successful completion of the course, students will be able to: 1. Explain the principles, mechanisms, and industrial applications of major unit processes used in chemical manufacturing. 2. Identify and classify industrial solid wastes and suggest appropriate treatment and disposal methods. 3. Analyze hazardous waste types and apply safe handling and disposal techniques according to environmental guidelines. 4. Apply scientific principles to reduce waste generation and improve efficiency in chemical processes.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	1. Basic principle of each unit process 2. Effect of reaction conditions (temperature, pressure, catalyst) on yield 3. Types and sources of solid waste in industries 4. Identification of toxic, corrosive, flammable, and reactive substances 5. Safe disposal methods (chemical treatment, incineration, encapsulation)	**Experiential Learning (Learning by Doing)** Hands-on activities such as neutralization of waste, composting, and adsorption studies **2. Problem-Based Learning** Real-life industrial problems are given, such as: How to treat acidic/alkaline effluents safely **3. Project-Based Learning** "Design of a small-scale waste management system for campus" **4. Inquiry-Based Learning** Why certain reaction conditions increase waste formation

Experiments	1. Study of bromination reaction of phenol 2. Identification test for halogen compounds in organic samples. 3. Preparation of p-bromo-acetanilide by bromination reaction. 4. Determination of iodine value of edible oil before and after hydrogenation. 5. Determination of moisture content in industrial solid waste. 6. Determination of ash content in industrial solid waste. 7. Estimation of total dissolved solids (TDS) in industrial wastewater. 8. Estimation of chemical oxygen demand (COD) of industrial effluent. 9. Estimation of biological oxygen demand (BOD) of wastewater sample. 10. Study of adsorption process using activated charcoal for waste treatment. 11. Preparation of ethyl acetate from acetic acid and ethanol. 12. Preparation of benzyl acetate by esterification reaction. 13. Preparation of aspirin through esterification of salicylic acid.	How adsorption reduces pollution load **5. Case Study Method** Analysis of causes, consequences, and preventive measures **6. Demonstration-Based Teaching** Waste treatment techniques (filtration, neutralization, adsorption) **7. Collaborative Learning (Group Work)** Group experiments on waste segregation and treatment **8. ICT-Enabled Learning** Use of videos showing industrial unit operations Virtual simulations of chemical plants and waste treatment units
Suggested Student Activities	1. Draw process flow diagrams for various unit processes 2. Model Making of Industrial Reactors 3. Identify unit processes involved in household products (soap, detergent, fertilizer). 4. Seminar Presentation 5. Prepare diagram/model of landfill, incineration, recycling plant. 6. Visit to Waste Treatment Plant 7. Poster Making Activity	
References	1. Practical Organic Chemistry by A.I. Vogel, Pearson Education 2. Advanced Practical Organic Chemistry by N.K. Vishnoi, Vikas Publishing House 3. Practical Organic Chemistry by F.G. Mann and B.C. Saunders, Pearson Education 4. Laboratory Manual of Organic Chemistry by R.K. Bansal, New Age International Publishers 5. Practical Chemistry by O.P. Pandey et al., S. Chand Publishing 6. Experimental Organic Chemistry by Louis F. Fieser, CBS Publishers & Distributors 7. Macroscale and Microscale Organic Experiments by Kenneth L. Williamson, Cengage Learning 8. Organic Chemistry Laboratory Techniques by Pavia et al., Cengage Learning **Web Resources** 1. https://www.epa.gov 2. https://cpcb.nic.in 3. https://www.chemguide.co.uk 4. https://www.britannica.com/science/industrial-chemistry 5. https://nptel.ac.in	
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities — 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * — 10 Marks
- Submission of duly certified practical record — 05 Marks

Total — **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 — 10 Marks
- Exercise 2 — 10 Marks
- Viva-Voce (external) — 05 Marks

Total — **25 Marks**

Course Category: **Vocational Skill Course VSC**

120253 Industrial Chemistry Lab- 24

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120253**	**Industrial Chemistry Lab- 24**	2	60	4 Hrs	50

Course Objectives:	1. Understand the basic principles of green chemistry and apply them in preparation of eco-friendly products and waste minimization practices. 2. Develop practical skills in paper and pulp processing, recycling techniques, and testing of paper materials. 3. Gain hands-on experience in simple chromatographic techniques for separation and identification of components in natural and synthetic samples. 4. Acquire knowledge of industrial safety practices, hazard identification, and safe handling of chemicals in laboratory and industrial environments.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Perform basic green chemistry experiments such as preparation of eco-friendly products using safe methods. 2. Carry out simple chromatographic separations (paper chromatography/TLC) and interpret results using Rf values. 3. Analyze environmental impact of chemical processes and suggest green alternatives for industrial applications. 4. Develop vocational skills such as observation, reporting, teamwork, and basic analytical thinking. 5. Connect laboratory experiments with real-life industrial and environmental applications.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	1. Importance of green chemistry in reducing environmental pollution. 2. Selection of eco-friendly raw materials (plant extracts, waste materials). 3. Principle of separation based on adsorption and partition. 4. Importance of laboratory and industrial safety rules.	To enhance student engagement and learning outcomes, the following pedagogical approaches will be incorporated: • **Experiential Learning (Hands-on Laboratory Work)** • **Inquiry-Based Learning** • **Collaborative Learning** a. Facilitate group-based experimental work to enhance teamwork and problem-solving skills. b. Conduct peer discussions on challenges and improvements in experimental procedures.

Experiments	1. Preparation of Handmade Paper from Waste Paper 2. Pulp Formation from Agricultural Waste like banana stem 3. Preparation of plate for TLC and separation of plant pigments. 4. Comparison of Different Paper Types with respect to thickness, texture and absorbency test. 5. Preparation of Activated Charcoal from Coconut Shell 6. Preparation of biodegradable Plastic from Starch and glycerol 7. Measurement of capillary action of various paper samples. 8. Measurement of pH of Paper Pulp Slurry 9. Separation of Oil–Water Using Natural Adsorbents like Coconut husk or sawdust filtration. 10. Determination of Moisture Content in Paper 11. Preparation of Natural Dye using turmeric, hibiscus, beetroot extracts. 12. Estimation of total alkali content in soap 13. Preparation of phenolphthalein Indicator dye. 14. To determine the acidity or alkalinity of a paper sample by measuring the pH.	• **Case-Based and Problem-Solving Approach** • **Assessment through Reflective Learning** a. Encourage students to maintain lab journals for recording observations and interpretations. b. Conduct oral presentations and report writing to develop scientific communication skills. • **Environmental Awareness Campaign** a. Students prepare posters/models on water pollution, soil degradation, and sustainable agriculture. b. Conduct awareness sessions within campus or nearby schools/villages.
Suggested Group Activities	1. Mini Project: "Eco-Friendly Product Development" 2. Poster Making: Green Chemistry & Safety Awareness 3. Model of Paper Recycling Plant 4. Chromatography Color Art Activity 5. Industrial Visit Report Writing 6. Waste Segregation Campus Activity 7. Group Discussion on Industrial Accidents	
References	1. Green Chemistry: Theory and Practice by Paul T. Anastas & John C. Warner by Oxford University Press 2. Practical Green Chemistry for Undergraduate Students by M. Lancaster, Royal Society of Chemistry (RSC) 3. Handbook of Pulp and Paper Technology by H. Sixta, Wiley-VCH 4. Chromatographic Methods by Braithwaite & Smith, Springer 5. Green Chromatographic Technique edited by Inamuddin & Ali Mohammad, Springer **Web Resources:** 1. https://nptel.ac.in 2. https://www.vlab.co.in 3. https://epgp.inflibnet.ac.in 4. https://ncert.nic.in	
Model Questions:	**NA**	

Distribution of Marks and the scheme of (VSC) Practical Examination is as follows:

Section I: Continuous Internal Assessment

- Continuous Assessment Tests (CAT) (At least three tests) * 15 Marks
- Submission of duly certified practical record 10 Marks

Total **25 Marks**

Section II: End Semester Examination (Internal only)

- Exercise 1 20 Marks
- Viva-Voce (internal) 05 Marks

Total **25 Marks**

Total (Section I And II) **50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Course Category: **Internship / Apprenticeship/ OJT**

120254 Internship / Apprenticeship/ OJT (On the Job Training)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	**120254**	**Internship / Apprenticeship/ OJT (On the Job Training)**	4	80	--	100

Course Objectives:	1. To provide hands-on training in chemistry-related industries, laboratories, and research organizations. 1. To expose students to industrial practices, instrumentation, quality control, and safety 2. procedures. 2. To enhance problem-solving, teamwork, communication, and technical skills. 3. To create awareness regarding entrepreneurship and employment opportunities in chemistry.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Apply theoretical chemistry concepts in practical and industrial environments. 2. Operate and understand basic analytical instruments and laboratory techniques. 3. Demonstrate professional ethics, laboratory safety, and teamwork. 4. Analyze chemical processes, observations, and experimental data effectively. 5. Prepare technical reports and communicate scientific findings professionally. 6. Explore employability and entrepreneurship skills in chemistry-related sectors.

Guidelines/ SoP for Internship / Apprenticeship/ OJT

For understanding key principles of Intrnship/Apprentiship/OJT operational guidelines and implementation strategy please refer

1. https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-Internship-Guidelines.pdf
2. https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf

As per NEP 2020, students of B Sc. III need to undertake Internship / Apprenticeship/ OJT for FOUR (4) credits i.e. 100 Marks.

The guidelines for Internship / Apprenticeship/ OJT are as follows:

2. **Credit: 04**
3. **Duration: 120 Hrs**
4. **Internship Period**: Ideally, the internship should be completed during the summer break between the second and third year. Students who are unable to complete the internship during this period must ensure its completion by the end of the VI semester, either in a part-time manner during Semester V, or during the Diwali break, or winter break or through an alternative arrangement subject to prior approval by the parent institution (University School/College).
5. **Internship Categories:**
   i. **Internship for enhancing the employability:** Employability is a set of skills and attributes developed through a range of experiences at workshops and workplaces.
   ii. **Internship for developing the research aptitude:** Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, equipment, policy framework and various other aspects in pursuing quality research.
6. **Implementation and assessment**: For implementation and assessment of this vertical a separate SoP or relevant document that shall be provided by the University will be applicable.
7. These can be implemented through:
   1. Industries
   2. Research labs
   3. Government testing laboratories
   4. Colleges/departments
   5. MSMEs and startups
   6. Online/virtual internships with report and viva evaluation

Some suggested forms of Internship / Apprenticeship/ OJT are:

Laboratory and Analytical Training:

1. Water quality testing laboratory internship
2. Soil and fertilizer analysis training
3. Food and dairy testing laboratory apprenticeship
4. Edible oil analysis and quality control training

5. Pharmaceutical quality control laboratory training Clinical pathology and diagnostic laboratory exposure
6. Environmental monitoring and pollution analysis internship
7. Industrial analytical chemistry laboratory training

Chemical Industry-Based OJT

1. Internship in chemical manufacturing units
2. Paint, dye, pigment, and polymer industry training
3. Soap, detergent, and cosmetic industry apprenticeship
4. Agrochemical and pesticide formulation training
5. Distillery, sugar, or fermentation industry exposure
6. Cement, ceramic, or glass industry laboratory training
7. Electroplating and metal finishing industry training

Research and Academic Exposure

1. Internship in university or research laboratories or premier institutes like IITs/IISERs etc.
2. Spectroscopy and instrumentation laboratory training
3. Computational chemistry or chemoinformatics training
4. Nanochemistry and material characterization exposure
5. Scientific documentation and laboratory management training

Entrepreneurship and Skill-Based OJT

1. Small-scale chemical product preparation: Oil, Soap, Sanitizer, Phenyl, Detergent, Herbal products etc.
2. Food preservation and quality analysis training
3. Entrepreneurship in chemical products and formulations
8. Laboratory chemical preparation and packaging training

References	1. https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-Internship-Guidelines.pdf 2. https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf
Model Questions:	**NA**