Format K1

Maharashtra State Board of Technical Education, Mumbai

TEACHING PLAN (TP)

Academic Year: **2025-26 (Even)**

Institute Code and Name: 0078- K. K. Wagh Polytechnic, Nashik **Semester**: Second

Programme and Code: Chemical Engineering (CH) **Course Index:** 602

Course and Code: Emerging Trends in Chemical Engineering (ETCE) (316301)

Name of Faculty: Dr. P. S. Bhandari **Class: TYCH**

INDUSTRY / EMPLOYER EXPECTED OUTCOME

After completing the course, learners will be able to create a waste reduction plan, identify process intensification opportunities, integrate green chemistry, compare materials and separation techniques, and explore industry 4.0 principles.

Course Outcomes (COs):

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO602.1	Identify ecofriendly/sustainable practices in the chemical industry.
CO602.2	Develop awareness about advanced and nanomaterials in the chemical industry.
CO602.3	Explore process intensification aspects in the chemical industry.
CO602.4	Prepare waste reduction or utilization plan for the given industry.
CO602.5	Develop awareness about digital technologies applicable to the chemical industry.

Teaching Learning outcome(TLO):

TLO 1.1	Identify the strategies for sustainable chemical manufacturing.
TLO 1.2	List out the step in the process with more environmental impact.
TLO 1.3	Analyze the atom economical process from the given reactions.
TLO 1.4	State the objectives of National Green Hydrogen Mission.
TLO 2.1	State the different types of advanced material.
TLO 2.2	Classify the materials on the basis of given criteria.
TLO 2.3	Explain the properties of nanomaterials.
TLO 2.4	Select the suitable material for a given application.
TLO 3.1	Comprehend the process intensification strategies.
TLO 3.2	Distinguish between characteristics of micro reactor and traditional chemical reactor.

TLO 3.3	Differentiate between the traditional over advanced separation processes on the basis of novelty and effectiveness
TLO 3.4	Select relevant advanced separation process for a given application.
TLO 4.1	Explore the circular economy approach for a process under consideration.
TLO 4.2	Prepare the waste reduction plan on the basis of 5R approach.
TLO 4.3	Explain waste valorizations approach.
TLO 4.4	Propose ZLD approach for given system.
TLO 5.1	Analyze the transformation of chemical industry from Industry 1.0 to Industry 4.0.
TLO 5.2	Explain the function of different components of chemical industry.
TLO 5.3	Explain role of artificial intelligence and machine learning in chemical industry.

. SUGGESTED COS - POS MATRIX FORM

CO	**Programme Outcomes (POs)**							**Programme Specific Outcomes (PSOs)**	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2 Problem Analysis**	**PO-3 Design/ Development of Solutions**	**PO-4 Engineering Tools**	**PO-5 Engineering Practices for Sustainability**	**PO- 6 Project Management**	**PO - 7 Life Long Learning**	**PSO- 1**	**PSO- 2**
CO1	03	02	02	02	03	-	03	03	03
CO2	02	01	01	-	02	-	03	03	03
CO3	03	02	01	-	03	-	03	03	03
CO4	03	03	02	02	03	-	03	03	03
CO5	02	01	-	01	02	-	03	03	03
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level									

Unit No. (Hrs.)	CO	TLO	Title/Topic Details/COs	Plan (From -to & No. of Lect.)	Actual Exe. (From to & No. of Lectures)	Teaching Media/ Methods	Remark
Unit I Sustainable strategies for Chemical industry							
I (06)	CO1	TLO1.1	1.1 Necessity to shift from traditional Chemical Industry to Green Chemical industry(02).	16/12/25 to 17/12/25			
		TLO1.2	1.2 Integration of ecofriendly practices in raw material processing, unit processes and unit operations and brief explanation with reference to following points: i. Waste reduction and minimization ii. Improving economy iii. Enhancing efficiency iv. Alternate pathways for ecofriendly Manufacturing(05).	17/12/25 to 24/12/25			1 extra
		TLO1.3	1.3 Green chemistry: Concept and 12 Principles of green chemistry, concept of atom economy and E-factor(03).	24/12/25 to 30/12/25			
			1.4 India's hydrogen mission and key consideration: i. National Green Hydrogen Mission(NGHM): Objectives and key targets by 2030 ii. Properties of hydrogen such as colour, odour, density, melting point, boiling point, specific heat and calorific value. iii. Types of hydrogen such as green, blue and grey hydrogen (02). iv. List of different hydrogen manufacturing methods.	31/12/2025			

Unit No. (Hrs.)	CO	TLO	Title/Topic Details/COs	Plan (From -to & No. of Lect.)	Actual Exe. (From to & No. of Lectures)	Teaching Media/ Methods	Remark
			v. Key considerations related to the safety and storage of hydrogen.				
Unit II Advanced Materials and Nanotechnology							
II (05)	CO2	TLO2.1	2.1 Brief overview and classification of different advanced materials such as: i. Carbon material ii. Composites iii. Nanomaterials iv. Semiconductor materials with examples(03).	01/01/26 to 07/01/26			
		TLO2.2	2.2 Nanomaterials and related terminologies: Nanoscale, nanomaterial, nanofiber, nanotube, nanoparticle, nanotechnology(02).	07/01/26 to 08/01/26			
II (05)	CO2	TLO2.3	2.3 Properties of nanomaterials: Physical, Chemical, Electrical and Optical(03).	13/01/26 to 14/01/26			
		TLO2.4	2.4 Application of nanomaterials: i. In a catalysis ii. As an energy storage material iii. As a nanocomposite iv. In a wastewater treatment (04).	15/01/26 to 21/01/26			

Unit No. (Hrs.)	CO	TLO	Title/Topic Details/COs	Plan (From -to & No. of Lect.)	Actual Exe. (From to & No. of Lectures)	Teaching Media/ Methods	Remark
Unit III Process Intensification and Advanced Separation Processes							
III (12)	CO3	TLO3.1	3.1 Process Intensification :Concept and importance. Brief description of process intensification by microwave, cavitation (acoustic and hydrodynamic) and photocatalysis (two examples of each)(04).	22/01/26 to 04/02/26			
		TLO3.2	3.2 Microreactors: Concept , sketch, salient features and application. Difference between plug flow reactor and micro-reactor(04).	05/02/26 to 11/02/26			
		TLO3.3	3.3 Advantages and applications of advanced Separation process over traditional distillation, extraction processes: i. Reactive distillation versus simple distillation e.g. Production of methyl acetate from methanol and acetic acid, Production of isopropyl acetate from isopropyl alcohol and acetic acid, and production of dimethyl ether from methanol. ii. Membrane distillation versus azeotropic distillation Air gap Membrane distillation for separation of azeotropic mixture of HCl - water) iii. Supercritical fluid extraction(SCF) versus leaching: Examples of Supercritical fluids. Applications of SCF:	12/02/26 to 19/02/26			1 extra

Unit No. (Hrs.)	CO	TLO	Title/Topic Details/COs	Plan (From -to & No. of Lect.)	Actual Exe. (From to & No. of Lectures)	Teaching Media/ Methods	Remark
			Decaffeination of coffee from coffee beans. Extraction of essential oils from geranium. Extraction of flavours from mint, Extraction of fat from coconut oil(06).				
Unit IV – Circular Economy and Waste Valorization in Chemical Industry							
V (12)	CO4	TLO4.1	4.1 Concept of circular economy and industrial ecology(01).	24/02/26 to 25/02/26			
		TLO4.2	4.2 Approach for integrating circular economy and waste minimization concept in chemical industries by designing process for reuse, recycle, reduce, refuse and repurpose of waste(03).	25/02/26 to 03/03/26			
		TLO4.3	4.3Valorization in chemical industry by converting waste into resource such as: i. Pyrolysis of plastics and tyre. ii. Extraction of valuable chemicals from vegetable waste iii. Biomass residue for production of chemicals by valorization (e.g. 2G technology for ethanol manufacturing)(05).	04/03/26 to 11/03/26			
		TLO4.4	4.4 Zero liquid discharge(ZLD) System and application: Concept and basic steps in ZLD system (pretreatment - concentration-crystallization-filtration-drying). Names and function of component in ZLD system: Sedimentation tank, Membrane filter	11/03/26 to 18/03/26			2 extra

Unit No. (Hrs.)	CO	TLO	Title/Topic Details/COs	Plan (From -to & No. of Lect.)	Actual Exe. (From to & No. of Lectures)	Teaching Media/ Methods	Remark
			(UF/NF/RO), Evaporator (Multiple Effect Evaporator), Crystallizer, Filter, Dryer or combination of above equipment(05).				
Unit V Industry 4.0 and Digital Chemical Industry							
V (10)	CO5	TLO5.1	5.1 Journey from Industry 1.0 to Industry 4.0 : Meaning of the terms and comparative difference(02)	19/03/26			1 extra
		TLO5.2	5.2 Digital chemical industry: Concept and benefits to chemical industry(02).	24/03/26			1 extra
			5.3 Components of digital chemical industry and functions IIoT sensors Advanced control systems Cloud computing and data analysis(02).	25/03/26			
		TLO5.3	5.4 Future trends in Chemical Engineering : Applications of Artificial intelligence and machine learning in the chemical industry(02).	26/03/26			1 Extra

References:

S.N.	Title of Book	Author	Publication
1	Green Chemistry: Theory and Practice	Anastas Paul	OUP UK, ISBN-13: 978-0198506980
2	Green Chemistry for Environmental Remediation	Rashmi Sanghi (Editor), Vandana Singh (Editor)	Wiley-Scrivener; 1st edition, ISBN-13 : 978-0470943083
3	Textbook of Nanoscience and Nanotechnology	B.S.Murty , P. Shankar , Baldev Raj, B. B. Rath Murdev J	Springer-Verlag Berlin and Heidelberg GmbH & Co. K; Softcover reprint of the original 1st ed. 2013 edition (23 August 2016) ISBN : 978-3662509128
4	Sustainable Process Engineering	Gyorgy Szekely	Szekely, Gyorgy. Sustainable Process Engineering, Berlin, Boston: De Gruyter, 2024. https://doi.org/10.1515/9783111028163

2. Learning websites and Portal:

S.N	Link / Portal & Description
1	https://nptel.ac.in/courses/118102003 NPTEL course on "Nano structured materials-synthesis, properties, self-assembly and applications", IIT Delhi Prof. A.K. Ganguli
2	https://archive.nptel.ac.in/courses/103/103/103103152/ NIOSH Pocket Guide To Chemical Hazards
3	https://aiche.onlinelibrary.wiley.com/doi/epdf/10.1002/aic.1 Venkatasubramanian, V. (2019), The promise of artificial intelligence in chemical engineering: Is it here, finally? AIChE J., 65: 466-478. https://doi.org/10.1002/aic.16489
4	https://pubs.rsc.org/en/content/articlelanding/2021/ma/d0ma00807a Baig N, Kammakakam I, Falath W, Kammakakam I (2021) Nanomaterials: A review of synthesis methods, properties, recent progress, and challenges. Mater Adv 2:1821–1871. https://doi.org/10.1039/d0ma00807a
5	https://www.sciencedirect.com/science/article/abs/pii/S2214785319325507 Kolahalam LA, Kasi Viswanath I V., Diwakar BS, et al (2019) Review on nanomaterials: Synthesis and applications. Mater Today Proc 18:2182–2190. https://doi.org/10.1016/j.matpr.2019.07.371
6	https://www.wjpps.com/Wjpps_controller/abstract_id/22237 Pardhi S, More S, et al (2025) atom economy? pioneering sustainable practices IN. 14:960–974. https://doi.org/10.20959/wjpps20251-28928

S.N	Link / Portal & Description
7	https://www.mdpi.com/2071-1050/17/1/335 Cansado IP da P, Mourão PAM, Castanheiro JE, et al (2025) A Review of the Biomass Valorization Hierarchy. Sustain 17:1–29. https://doi.org/10.3390/su17010335
8	https://bombaytechnologist.in/index.php/bombaytechnologist/article/download/173197/117166 Thakur S, Deo A, Dhawale M (2024) Novel Separation Processes and Their Applications. Bombay Technol. https://doi.org/10.36664/bt/2023/v70i1/173197
9	https://www.researchgate.net/publication/263327729 Kiran D. Patil (2014) Review of Green Chemical Technologies for Sustainable Developments in Chemical Process Industries. J Curr Trends Chem Eng. 2
10	https://www.sciencedirect.com/science/article/pii/S2095809917304198 Chen JF (2017) Green Chemical Engineering. Engineering 3:283–284. https://doi.org/10.1016/J.ENG.2017.03.025

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