THE MAHATMA GANDHI UNIVERSITY

UNDERGRADUATE PROGRAMMES

(HONOURS) SYLLABUS

MGU-UGP (Honours)

(2024 Admission Onwards)

Faculty: Science

Expert Committee: Chemistry

Subject: Industrial Chemistry

Mahatma Gandhi University
Priyadarshini Hills
Kottayam – 686560, Kerala, India

Syllabus Index

Name of Minor**: Industrial Chemistry**

Semester: 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG1DSCICH100	Fundamentals of Industrial Chemistry	DSC B	4	5	3		2	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG2DSCICH100	Major Chemical Industries	DSC B	4	5	3		2	

Semester: 3

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG3DSCICH200	Functional operations in Chemical industry	DSC B	4	5	3		2	

Semester: 4

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG4DSCICH200	Functional operations in Chemical industry	DSC C	4	5	3		2	

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Programme					
Course Name	**Fundamentals of Industrial Chemistry**				
Type of Course	**DSC B**				
Course Code	MG1DSCICH100				
Course Level	**100-199**				
Course Summary	This course explores key inorganic materials, basic metallurgical operations, corrosion, industrial aspects of organic chemistry and nanochemistry.				
Semester	I	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	75
Pre-requisites, if any	Fundamentals of organic and inorganic Chemistry				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply fundamental chemistry knowledge to enhance the efficiency, safety, and sustainability of chemical industries.	A	1, 2, 10.
2	Demonstrate proficiency in the selection of parameters for chemical industry processes	E	1, 2
3	Analyse availability, forms, structures, modifications, and basic industrial operations of key inorganic materials.	An	1, 2

4	Describe raw material extraction from petroleum/natural gas and the associated processes.	U	1, 2
5	Explain the fundamental concepts of nanochemistry	U	1, 2
6	Perform basic industrial chemistry experiments	A, S	1, 2,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Industrial chemistry**			
	1.1	The difference between classical and industrial chemistry, classification of Industries, the chemical industry- basic requirements and production of chemicals and raw materials. Unit processes and unit operations. (definition and example)	4	1
	1.2	Quality control, quality assurance, process control, research and development, pollution control, human resource, safety measures, economics of chemical process, selection of parameters of chemical industry, classification of chemical reactions, batch and continuous operations, industrial chemical reactions,	4	1,2
	1.3	Raw material for organic compounds: petroleum, natural gas-fraction of crude oil, fractional distillation, cracking, reforming, hydroforming, isomerisation. Octane number and cetane number, knocking and antiknock compounds.	7	2,4
	Materials of industrial importance			
	2.1	Inorganic materials of industrial importance: Alumina, silica, silicates, clay, mica, carbon, zeolites. Their availability, forms, structure and applications.	2	1,2,3

2	2.2	Organic chemicals of industrial importance: Cellulose and starch- properties, modification and important Industrial chemicals derived from them.	2	1,2,4
	2.3	Metallurgy: Basic metallurgical operations: pulverisation, calcination, roasting and refining. Physicochemical principle of extraction of iron, copper, aluminium, zinc, uranium and titanium. Steel- classification, heat treatment and passivity.	5	1, 3
	2.4	Corrosion Introduction, dry or chemical corrosion, wet or electrochemical corrosion, mechanism of electrochemical corrosion, factors influencing corrosion, corrosion control- proper designing, using pure metal, using metal alloys and cathodic protection. Chemical conversion– coating, phosphating, chromising and treatment of metal surfaces- hot dipping. Use of inhibitors. Rusting of iron-electron transfer and chemical theory and prevention.	6	1
3		**Nanochemistry**		
	3.1	Introduction: Definition and length scales. Classifications of nanomaterials. Comparison of bulk and nanomaterials. Introduction to 'top down' and 'bottom up' approach of synthesis with suitable examples. Characteristics of Nanomaterials: nucleation and growth of nanosystems, self-assembly. Nano in Nature: Gecko Effect, lotus leaf effect, superhydrophobicity, self-cleaning and antifogging – colored glasses and dichroism Nano synthesis techniques: chemical vapour deposition and sol -gel methods.	7	5
	3.2	Advanced Nanostructured Materials: Preparation and Properties and applications of graphene, CNTs and fullerenes. Nanorods, nanofibre, nanowires, nanoclay, quantum dots and nanocomposites. Toxic effects of nanomaterials.	8	1,2,6
4	**Fundamentals of Industrial Chemistry Practical**			

		1. Simple laboratory techniques: crystallisation and distillation. 2. Estimation of copper in brass. 3. Water Analysis i) Estimation of hydroxide alkalinity, carbonate and bicarbonate alkalinity of the given water sample volumetrically ii) Estimation of chloride in water iii) Determination of total, temporary and permanent hardness using EDTA. iv) Estimation of chloride in water v) Determination COD of the given water sample vi) Estimation of dissolved oxygen by Winkler's method 4. Ore Analysis i) To analyse the amount of calcium present in a given sample of limestone. ii) Quantitative analysis of calcium and magnesium in dolomite by complexometric titration. iii) Estimation of Iron in iron ore. iv) Estimation MnO_2 in pyrolusite	30	6
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture Tutorial Hybrid ICT enabled teaching and learning Demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory (25 marks)** Assignments/ MCQ/ viva/ class test: **Practical (15 marks)** Lab involvement and report /Lab test

	B. Semester end examination **Theory (50 marks)- 1.5 hrs** MCQ 10 questions: 10 X 1 = 10 Short answer 4 questions (out of 6): 4 X 3 =12 Short essay 4 questions (out of 6): 4 X 7 = 28 **Practical (35 marks)- 1 hr.** Lab report : 10 Viva : 10 Writing procedure; 15

References

1. B. K. Sharma, *Industrial Chemistry*, Krishan Prakashan, 2014.

2. L.F.Hath, S. Matarm*, From Agro Carbons to petrochemicals,* Gulf publishing Co., Houston.

3. R.E. J. Hoffmann, *Coal conversion*, the Energon Co. Lavamic, Wyoming USA

4. R.W.Kerr, *Chemistry and industry of starch*, Academic Press Inc. Publishers, New York.

5. J. Bockris and K. N. Reddy, Modern Electrochemistry 2B, 2nd Edition, Springer, 2018.

6. S. K. Friedlander, *Smoke, Dust and Haze: Fundamentals of Aerosol Behaviour*. New York: John Wiley & Sons.

7. E. Stocchi, *Industrial Chemistry, Vol-I*, Ellis Horwood Ltd. UK.

8. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.

9. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.

10. J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.

11. R. Gopalan, D.Venkappayya, S.Nagarajan, *Engineering Chemistry*, Vikas Publications, New Delhi

12. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 8th Edn. Brooks/Cole Nelson, 2018.

13. *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn, Pearsons Education Ltd.

14. Vogel's Qualitative Inorganic Analysis, 7th Edn. Pearson Education Ltd.

15 S.S. Dara, *A text book on experiments and calculations in engineering chemistry*, S. Chand & Company Ltd., Delhi, 2015.

16. S. Rani, S. K. Bashin, *Laboratory Manual on Engineering Chemistry*, Dhanpat Rai, 2012.

17. Gurdeep Raj, *Advanced Practical Inorganic Chemistry*, Goel Publishing House, 2020.

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Programme					
Course Name	**Major Chemical Industries**				
Type of Course	**DSC B**				
Course Code	MG2DSCICH100				
Course Level	**100-199**				
Course Summary	This course deals with different types of chemical industries and practical aspects of industrial chemistry.				
Semester	II	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	75
Pre-requisites, if any	Basics of industrial chemistry				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse various industries in chemistry	An	1, 2
2	Explain the applications of chemistry in various fields	U	1, 2
3	Demonstrate the types, functioning and applications of batteries.	U	1, 2
4	Describe different types of polymers and polymer processing techniques.	U	1, 2
5	Explain the fundamental aspects of non-petroleum fuels.	U	1, 2
6	Conduct basic industrial chemistry experiments.	A, S	1, 2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Silicate and Ceramics Industries			
1	1.1	Silicate Industries Glass: Glassy state and its properties, Classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following: soda lime, lead, armoured, safety, borosilicate, fluorosilicate, coloured and photosensitive glasses.	6	1,2
	1.2	Ceramics: Ceramic, their types and manufacture. High technology ceramics and their applications, super conducting and semiconducting oxides, fullerenes, carbon nanotubes and carbon fibre, clays and feldspar.	6	1,2
	1.3	Surface Coatings: objectives, preliminary treatment of surface and classification of surface coatings. Paints and pigments - formulation, composition and related properties.	3	1,2
	Battery			
2	2.1	Batteries: Primary and secondary batteries, basic theory, electrochemical cell, EMF of the cell, Nernst equation and EMF.	6	1,2,3
	2.2	Battery components and their role and. The discharge plot, the ragone plot and measures of battery performance	4	1,2,3
	2.3	Working of Pb acid, Li- ion and solid state electrolyte battery. Fuel Cells, solar cells and polymer cells.	5	1, 2, 3
	Polymer Industry and Non-petroleum Fuels			

3	3.1	Polymer industry: Plastics- thermosetting and thermoplastics-moulding of plastics into articles-compression moulding, injection moulding, transfer moulding, extrusion moulding, blow moulding and transfer moulding. Other methods for plastic processing- calendaring, casting, thermoforming, foaming	8	1, 2,4
	3.2	Non-petroleum fuels - CNG, LNG, biodiesel, bio-gas, fuels derived from bio-mass; fuel from waste; gaseous fuels. Basic idea about synthetic fuels-Fischer-Tropsch synthesis and Bergius process. Coal: types- distillation of coal-carbonization-types of carbonization. Distillation of coal tar-chemicals derived from them. Analysis of coal–ultimate analysis and proximate analysis.	7	1, 2, 5
	Practical			
4	1. Alloy analysis i) Estimation of copper in brass ii) Estimation of zinc in brass 2. To determine the percentage of $NaHCO_3$ in a mixture of $NaHCO_3$ and NaCl. 3. Determination of weight percent of acetic acid in vinegar. 4. Determination of percentage of iron in Mohr's salt. 5. Determination of the percentage of silica, calcium, magnesium and iron in the given cement sample. 6. Identification of cations in the mixture by paper chromatography		30	6
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).

Assessment Types	**MODE OF ASSESSMENT** **A.** **Continuous Comprehensive Assessment (CCA)** **Theory (25 marks)** Assignments/MCQ/Viva/Involvement in classroom activities **Practical (15 marks)** Lab involvement and report /Lab test
	B. Semester end examination **Theory (50 marks)-1.5 hrs.** MCQ 10 questions : 10 X 1 = 10 Short answer 4 questions (out of 6): 4 X 3 =12 Short essay 4 questions (out of 6): 4 X 7 = 28 **Practical (35 marks)-1 hr.** Lab report: 10 Viva: 10 Writing procedure: 15

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Programme					
Course Name	**Functional operations in Chemical industry**				
Type of Course	DSC B				
Course Code	MG3DSCICH200				
Course Level	**200-299**				
Course Summary	This course explores relevant industrial operations and processes with examples of effluent treatment and water purification processes				
Semester	III	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	Industrial Visit
					75
Pre-requisites, if any	Fundamental knowledge on boiling point, solubility and nature of solvents.				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the basic concepts and fundamental principles of unit operations.	U	1,3
2	Analyse and compare the advantages, limitations, and applications of various equipment in each unit operations	An	1,2,3
3	Demonstrate the correct use of equipment in practical applications.	E, S	1,2,3,10
4	Evaluate the efficiency and effectiveness of different unit operations.	E	1,2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Unit Operations in Industries – introduction, types of operations, heat and mass transfer, fluid flow operations (laminar and turbulent flow, Bernoulli's principle, and Reynolds number.) (elementary idea)	2	1
	1.2	Evaporation: principle, forced circulation, falling film, climbing film (upward flow) and wiped (agitated) film evaporators.	6	2,3,4
	1.3	Distillation-principle, types of distillation: simple, equilibrium, fractional, steam and vacuum distillations, batch and continuous distillation. Rectification, construction of rectifying column and type of columns: packed and plate columns.	8	2,3,4
	1.4	Filtration: introduction: filter media and filter aids (elementary idea). Equipment-plate and frame filter press, nutch filter, rotary drum filter. Introduction to drying process, types of dryers: -tray dryer, rotary dryer, flash dryer, spray dryer	7	2,3,4
2	2.1	Crystallisation: principles and stages of crystallisation.	2	1
	2.2	Crystal growth techniques-crystallisation from melt-Bridgman method, Czochralski method, floating zone method, Verneuil method.	4	2,3,4
	2.3	Crystallisation equipment- draft tube crystalliser, MSMPR crystalliser.	4	2,3,4
3	3.1	Mixing: Introduction, mixing of liquid-liquid, solid-liquid and solid-solid systems Equipment for mixing: trough mixer, paddle mixer, tumbler mixer.	4	2,3,4
	3.2	Extraction: Principle and types of extraction (liquid-liquid, solid-liquid, supercritical extraction)	4	1,2

	3.3	Supercritical fluid extraction-theory and instrumentation	4	2,3,4
4	**Functional operations in Chemical industry Practicals**			
	Distillation: To Perform a expt. on Simple Distillation using binary mixture (Methanol + Water or Ethanol+Water)		30	3,4
	Heat of Solution KNO_3, NH_4Cl			
	Heat of neutralization			
	Crystallisation – Any four compounds using ethyl acetate, ethanol, and water – Record the yield of recovery			
	Solvent extraction – aniline from water - methyl benzoate from water - using ether- and record the yield of recovery.			
	To study the rate of drying of solid substances: saw dust or cardboard.			
	To study the rate of drying of liquid substances			
	To crystallise the given sample of phthalic acid from hot water using fluted paper nod stemless funnel.			
	To crystallise the given sample of benzoic acid from hot water using fluted paper nod stemless funnel			
	Determine the rate of evaporation of a given liquid sample (thin solution of sugar + water, NaCl+water) in an open pan evaporator.			
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** ICT enabled demonstrations Group discussion Lecture
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory (25 marks)** Assignments/MCQ/viva/Involvement in classroom activities **Practical (15 marks)** Lab involvement / report /Lab test
	B. Semester end examination **Theory (50 marks)-1.5 hrs.** MCQ 10 questions : 10 X 1 = 10 Short answer 4 questions (out of 6): 4 X 3 =12 Short essay 4 questions (out of 6): 4 X 7 = 28 **Practical (35 marks)-1 hrs.** Lab report: 10 Viva: 10 Writing procedure: 15

References

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2. W.L.McCabe and J.C.Smith, *Unit operations in Chemical Engineering*, Tata McGraw Hill, 2018.

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5. K.A.Gavhane, Unit Operations-II Heat and Mass transfer, NiraliPrakashan.

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7. J.F. Richardson, J. H. Harker, J. R. Backhurst, Particle Technology and Separation Processes, Butterworth-Heinemann.

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9. *Vogel's Textbook of Practical Organic Chemistry,* 5th Edn, Pearson Education, 2005.

10. F.G.Mann, B.C. Saunders, *Practical Organic Chemistry*, 4th Edn, Pearson Education, 2009.

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Programme					
Course Name	**Functional operations in Chemical industry**				
Type of Course	DSC C				
Course Code	MG4DSCICH200				
Course Level	**200-299**				
Course Summary	This course explores relevant industrial operations and processes with examples of effluent treatment and water purification processes				
Semester	III	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others
		3		1	Industrial Visit	75
Pre-requisites, if any	Fundamental knowledge on boiling point, solubility and nature of solvents.				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the basic concepts and fundamental principles of unit operations.	U	1,3
2	Analyse and compare the advantages, limitations, and applications of various equipment in each unit operations	An	1,2,3
3	Demonstrate the correct use of equipment in practical applications.	E, S	1,2,3,10
4	Evaluate the efficiency and effectiveness of different unit operations.	E	1,2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Unit Operations in Industries – introduction, types of operations, heat and mass transfer, fluid flow operations (laminar and turbulent flow, Bernoulli's principle, and Reynolds number.) (elementary idea)	2	1
	1.2	Evaporation: principle, forced circulation, falling film, climbing film (upward flow) and wiped (agitated) film evaporators.	6	2,3,4
	1.2	Distillation-principle, types of distillation: simple, equilibrium, fractional, steam and vacuum distillations, batch and continuous distillation. Rectification, construction of rectifying column and type of columns: packed and plate columns.	8	2,3,4
	1.3	Filtration: introduction: filter media and filter aids (elementary idea). Equipment-plate and frame filter press, nutch filter, rotary drum filter. Introduction to drying process, types of dryers: -tray dryer, rotary dryer, flash dryer, spray dryer	7	2,3,4
2	2.1	Crystallisation: principles and stages of crystallisation.	2	1
	2.2	Crystal growth techniques-crystallisation from melt-Bridgman method, Czochralski method, floating zone method, Verneuil method.	4	2,3,4
	2.3	Crystallisation equipment- draft tube crystalliser, MSMPR crystalliser.	4	2,3,4
3	3.1	Mixing: Introduction, mixing of liquid-liquid, solid-liquid and solid-solid systems Equipment for mixing: trough mixer, paddle mixer, tumbler mixer.	4	2,3,4
	3.2	Extraction: Principle and types of extraction (liquid-liquid, solid-liquid, supercritical extraction)	4	1,2
	3.3	Supercritical fluid extraction-theory and instrumentation	4	2,3,4

	Functional operations in Chemical industry Practicals		
4	Distillation: To Perform a expt. on Simple Distillation using binary mixture (Methanol + Water or Ethanol+Water)	30	3,4
	Heat of Solution KNO_3, NH_4Cl		
	Heat of neutralization		
	Crystallisation – Any four compounds using ethyl acetate, ethanol, and water – Record the yield of recovery		
	Solvent extraction – aniline from water - methyl benzoate from water - using ether- and record the yield of recovery.		
	To study the rate of drying of solid substances: saw dust or cardboard.		
	To study the rate of drying of liquid substances		
	To crystallise the given sample of phthalic acid from hot water using fluted paper nod stemless funnel.		
	To crystallise the given sample of benzoic acid from hot water using fluted paper nod stemless funnel		
	Determine the rate of evaporation of a given liquid sample (thin solution of sugar + water, NaCl+water) in an open pan evaporator.		
5	**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** ICT enabled demonstrations/Group discussion/ Lecture
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory (25 marks)** Assignments/MCQ/viva/Involvement in classroom activities **Practical (15 marks)** Lab involvement / report /Lab test

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