SEMESTER 3

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSCCHE200**				
Course Title	**PHYSICAL CHEMISTRY I**				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge 2. Basic understanding of calculus is preferred.				
Course Summary	This physical chemistry course covers a broad range of topics including solid state, liquid state, gaseous state, dilute solutions, and colloids, providing students with a comprehensive understanding of the properties and behaviours of matter at various states and concentrations. Through theoretical principles and practical experiments, students gain insights these topics and to apply their knowledge to solve real-world problems.				

Detailed Syllabus:

Module	Unit	Content PHYSICAL CHEMISTRY I	Hrs 75
I	**SOLID STATE**		**9**
	1	Amorphous and Crystalline solids. Isotropy and anisotropy, size and shape of crystal, Interfacial angle, types of crystals: molecular crystals, ionic crystals, covalent crystals and metallic crystals- examples and properties.	2
	2	Symmetry of crystals- plane of symmetry, axis of symmetry, centre of symmetry (definitions and basic idea only), Seven basic crystal systems, Space lattice and unit cell, Bravais lattices, (unit cell parameters and examples of 14 Bravis lattices), close packing structures of cubic and orthorhombic space lattices.	2
	3	Law of constancy of interfacial angles, Laws of rational indices, Miller indices, Representation of lattice planes of cubic crystals, interplanar spacing in crystals, Determination of Avogadro number from crystallographic data	2
	4	X-ray diffraction studies of crystals, Bragg's equation – derivation and applications, Rotating crystal and powder method. Structure of NaCl and CsCl, Imperfections in crystals. Stoichiometric and	2

		Nonstoichiometric defects, point defects – Schottky and Frenkel defects, F-centre	
	5	Energy band theory of Conductor, Semiconductors and insulators, Glasses	1
II	**LIQUID STATE**		**9**
	6	Physical properties of liquids; vapour pressure, surface tension, viscosity, and Refractive Index and their determination. Factors affecting surface tension and viscosity, Interfacial tension, Surface active agent, Explanation of cleansing action of detergents.	3
	7	Determination of Surface tension- capillary rise and stalagmometer method Viscosity- Poiseuilles equation, Determination of viscosity- Ostwald's viscometer Refractive index determination by Abbe refractometer	3
	8	Liquid crystals- introduction, characterization of liquid crystals, Types –smectic, nematic and cholesteric liquid crystals- examples; Disc shaped liquid crystals, Polymer liquid crystals. uses of liquid crystals	3
III	**GASEOUS STATE**		**9**
	9	Ideal gas, Ideal gas equation, gas constant: values in different units ($JK^{-1}mol^{-1}$, L atm $K^{-1}mol^{-1}$, cal $K^{-1}mol^{-1}$) Dalton' Law of Partial pressure- Definition and mathematical expression. Postulates of Kinetic theory of Gases and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity; variation of viscosity with temperature and pressure.	2
	10	Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartitions of energy and degrees of freedom.	2
	11	Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases, Causes of deviation from ideal behaviour. Z-P plots of ideal gas and the real gases H_2, He, NH_3, CO and methane at 0°C, Z-P plots of N_2 at several temperatures.	2
	12	Vander Waals equation of state, its derivation and application in explaining real gas behaviour. Vander Waal's equation at low and high pressures and at high temperature.	1
	13	Law of corresponding states, liquefaction of gas, inversion temperature PV isotherm of Carbon dioxide, critical state, relation between critical constants and van der Waals constants, Correction factors, Experimental determination critical constants, Boyle temperature, Boyle temperature in terms of van der waal's constant. Virial equation of state and virial coefficients. (no derivations).	2
IV	**DILUTE SOLUTIONS AND COLLOIDS**		**18**

	14	Dilute solutions: Binary solutions, Concentration- Molarity, Molality, Normality and Mole fraction. (numerical problems)	2
	15	Raoult's Law for solutions of non-volatile solutes, vapour pressure of ideal solutions and relative lowering of vapour pressure.	1
	16	Colligative properties- lowering of vapour pressure; elevation of boiling point and depression in freezing point; molal elevation constant, molal depression constant, Thermodynamic derivation of ΔT; Osmosis and Osmotic pressure, van't Hoff equation; Isotonic, hypertonic and hypotonic solutions, Abnormal molecular mass and van't Hoff factor, Determination of degree of dissociation and association, Reverse osmosis (numerical problems).	4
	17	Experimental determination of molecular mass of solutes by cooling curve method, Rast's and Beckmann methods	2
	18	**Colloids:** Classification of colloids – Preparation of colloids	2
	19	Purification of colloids – dialysis, electrodialysis, hot dialysis, ultra filtration ultra centrifugation	2
	20	Kinetic, optical and electrical properties of colloids – Tyndall effect & applications - Ultra microscope, Electrical double layer and zeta potential - Coagulation of colloids, Hardy-Schulz rule, Gold number, sedimentation and streaming potential	3
	21	Gels: Elastic and non-elastic gels, Imbibition and syneresis, Micelles and critical micelle concentration	1
	22	Application of colloids – Cottrell precipitator, purification of water and delta formation.	1
V	**PRACTICALS: PHYSICAL CHEMISTRY PRACTICALS**		**30**
		A minimum of 8 practical experiments (Minimum one each from A & B)	
	23	**A. Lowering of freezing point** 1. Determination of K_f of solid solvent using a solute of known molecular mass. (Solvent: Naphthalene, biphenyl) (Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine) 2. Determination of molecular mass of the solute using a solvent of known K_f. (Solvent: Naphthalene, biphenyl) (Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine)	8
	24	**B. Depression of transition temperature** 3. Determination of molal transition point depression constant (Kt) of salt hydrate using solute of known molecular mass. (Salt hydrates: sodium thiosulphate penta hydrate, hydrated sodium acetate) (solutes: Urea, Glucose). 4. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (Kt). (Salt hydrates: sodium thiosulphate penta hydrate, hydrated sodium acetate) (solutes: Urea, Glucose)	8
	25	**C. Surface tension:** 5. Determination of Surface tension of any three liquids	4

		6. Surface tension of binary mixtures and determination of concentration of an unknown mixture	
	26	**D. Viscosity:** 7. Determination of viscosity of any three liquids 8. Viscosity of binary mixtures and determination of concentration of an unknown mixture	4
	27	**E. Refractive index experiments:** 9. Determination of refractive indices of any three liquids 10. Refractive indices of KCl solutions of different concentrations and determination of concentration of unknown KCl solution	4
	28	**F. Solid state:** 11. Indexing powder XRD patterns and determination of unit cell parameters of simple and/or bcc and/or fcc systems (Instructors must provide the powder XRD patterns and ask students to index it and calculate unit cell parameters)	

References:

Textbooks

1. P W Atkins, "*Physical Chemistry*", Oxford University Press
2. R L Madan, *Physical Chemistry*, Mc Graw Hill
3. Glasstone and Lewis, *Elements of Physical Chemistry*, Macmillan
4. Puri, Sharma & Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co
5. P. C. Rakhit, *Physical Chemistry*, Sarat Book House, Calcutta
6. J. B. Yadav *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd

For Further Reading

1. R J Selby and RA Alberty, *Physical Chemistry*, John Wiley &sons
2. Levin, *Physical Chemistry*, 5th edn, TMH.
3. Gurdeep Raj, *Advanced Physical Chemistry*, Goel publishing house
4. G W Castellan, "*Physical Chemistry*", Narosa Publishing House
5. B. Viswanathan, P. S. Raghavan, *A Practical Physical Chemistry*, Viva Books.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Critically analyze the structural distinctions and physical properties of crystalline and amorphous solids through symmetry concepts, crystallographic parameters, packing arrangements, X-ray diffraction techniques, and defect analysis to interpret their influence on material behavior and electronic properties.	An	PSO -1,2,3

CO-2	Analyze the physical properties of liquids—including vapour pressure, surface tension, viscosity, and refractive index—by interpreting experimental methods and theoretical principles, and evaluate the structural characteristics and technological applications of liquid crystals based on their types and behavior.	An	PSO - 1,2,3,4
CO-3	Critically evaluate the behavior of ideal and real gases by applying gas laws, kinetic molecular theory, and equations of state, and analyze how deviations from ideality are explained through parameters such as compressibility factor, van der Waals constants, and virial coefficients under varying temperature and pressure conditions.	E	PSO -1,2,3
CO-4	Design and solve numerical and conceptual problems involving dilute solutions and colligative properties, derive thermodynamic relations, experimentally determine molecular masses, and construct models to explain the behavior, purification, and applications of colloids and gels based on their physical and chemical properties.	C	PSO - 1,2,3,4
CO-5	Design and execute experiments to determine colligative properties, surface tension, viscosity, refractive index, and crystal parameters by creatively applying theoretical concepts and analytical techniques to solve real-world and unknown system problems.	C	PSO - 1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICAL CHEMISTY I

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO-1,6 PSO -1,2,3	An	F, C	L	-
2	CO-2	PO-1,6 PSO -1,2,3	An	F, C	L	-
3	CO-3	PO-1,6 PSO -1,2,3,4	E	F, C, M	L	-
4	CO-4	PO-1,6 PSO -1,2,3	C	F, C	L	-

5	CO-5	PO-1,6 PSO -1,2,3	C	F, C, M, P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	3	3	3	-	-	1	-	-	-	-	2	-	-
CO 2	3	3	3	-	-	1	-	-	-	-	2	-	-
CO 3	3	2	3	2	-	1	-	-	-	-	2	-	-
CO 4	3	3	3	-	-	1	-	-	-	-	2	-	-
CO 5	1	2	3	-	2	1	2	-	-	-	3	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4	✓	✓		✓
CO 5	✓		✓	✓

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSCCHE201**				
Course Title	**ESSENTIALS OF PHYSICAL CHEMISTRY**				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge 2. First & second semester DSCs (chemistry) offered by UoK (preferable) 3. Basic knowledge in mathematics.				
Course Summary	The course gives students a thorough understanding of the fundamentals of physical chemistry and how they are applied in real-world situations. Topics covered include chemical and ionic equilibrium, electrochemistry, crystalline states, dilute solutions, and binary liquid systems. Students have practical experience in conducting physical chemistry experiments and analyzing experimental data through practical activities that help them build important laboratory skills.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		ESSENTIALS OF PHYSICAL CHEMISTRY	**75**
I	**CHEMICAL AND IONIC EQUILIBRIUM**		**9**
	1	Reversible reactions – K_P, K_C, and K_X and inter relationships – Free energy change and chemical equilibrium (thermodynamic derivation)	2
	2	Influence of pressure and temperature on the following reactions. (i) $N_2 + 3H_2 \rightarrow 2NH_3$ (ii) $PCl_5 \rightarrow PCl_3 + Cl_2$ (iii) $2SO_2 + O_2 \rightarrow 2SO_3$ Le Chatelier's principle and the discussion of the above reactions on its basis.	2
	3	Concepts of Acids and Bases, Arrhenius, Lowry-Bronsted, and Lewis concepts. HSAB Principle. Levelling effect.	1
	4	pH and its determination by potentiometric method. Buffer solutions – Henderson equation, Acidic and basic buffers-examples.	2

	5	Hydrolysis of salts – degree of hydrolysis and hydrolytic constant, Derivation of relation between K_w and K_h for salts of strong acid – weak base, weak acid - strong base and weak acid – weak base.	2
II	**ELECTRO CHEMISTRY**		**9**
	6	Application of conductance measurements. Conductometric titrations involving strong acid – strong base, strong acid – weak base, weak acid – strong base and weak acid – weak base.	2
	7	EMF – Galvanic cells, measurement of emf, cell and electrode potential, IUPAC sign convention, Reference electrodes, SHE and calomel electrode, standard electrode potential,	2
	8	Nernst equation, anion and cation reversible electrodes, redox electrode with examples, quinhydrone electrode, glass electrode	3
	9	Concentration cell without transference, potentiometric titration, Fuel cells – H_2 – O_2 and hydrocarbon – O_2 type.	2
III	**CATALYSIS AND PHOTO CHEMISTRY**		**9**
	10	General Characteristics of catalytic reactions. Different types of catalysis – examples	2
	11	Theories of catalysis (Outline of intermediate compound formation theory and adsorption theory).	2
	12	Enzyme catalysis – Michaelis-Menten mechanism.	2
	13	Photo Chemistry: - Laws of Photo Chemistry, Grothus – Drapter law, Beer Lambert's law, Einstein's laws, quantum yield, H_2 – Cl_2 reaction, H_2 – Br_2 reaction	2
	14	Fluorescence and phosphorescence, chemiluminescence and photo sensitization	1
IV	**DILUTE SOLUTIONS AND BINARY LIQUID SYSTEMS**		**18**
	15	Molarity, molality, Normality and mole fraction Colligative property – relative lowering of vapour pressure – elevation in boiling point – depression in freezing point – osmotic pressure – experimental determination of osmotic pressure – Isotonic solution – reverse osmosis	5
	16	Abnormal molecular mass - van't Hoff factor. (Numerical Problems to be worked out)	4
	17	Completely miscible liquid pairs, vapour pressure - composition curve, boiling point composition curve	3
	18	Ideal and non- ideal solutions, fractional distillations, azeotropes	3
	19	Partially miscible liquids - CST, phenol- water, nicotine-water system- Effect of impurities on miscibility and CST, Immiscible liquid pairs.	3
V	**PRACTICALS: PHYSICAL CHEMISTRY EXPERIMENTS**		**30**
		A minimum of 5 practical experiments out of which at least one each from sections I, II and III must be performed and reported.	
	20	**I. Conductometry**	5
		1. Determination of cell constant 2. Conductometric titration of NaOH using HCl	
	21	**II. Potentiometry**	6

		3. Potentiometric titration of Fe^{2+} versus $Cr_2O_7^{2-}$ 4. Potentiometric titration of KMnO4 versus KI	
	22	**III. Experiments with Partially miscible liquid pairs**	3
		5. Critical solution temperature of phenol –water system 6. Influence of KCl (impurity) on the miscibility temperature of Phenol-water system. Determination of concentration of given KCl solution	
	23	**IV. Adosrption Experiments**	6
		7. Freundlich and Langmuir isotherms for adsorption of oxalic acid on active charcoal. 8. Determination of unknown concentration of oxalic acid using isotherm.	
	24	**V. Calorimetry**	5
		9. Determination of water equivalent of Calorimeter and heat of neutralization of strong acid and strong base	
	25	**VI. Partition experiments**	5
		10. Partition coefficient of iodine between CCl_4 and H_2O or Partition coefficient of ammonia between $CHCl_3$ and H_2O	

References

1. P L Soni, O P Dharmarsha, U N Dash, *Textbook of Physical Chemistry*, 23rd Edn, Sultan Chand & Sons, New Delhi, 2011.
2. Gurudeep Raj, *Advanced physical chemistry*
3. F Daniel and R A Albert, *Physical chemistry*
4. N.M. Kapoor, *Physical Chemistry.*
5. J. B. Yadav *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand and apply the principles of chemical equilibrium, acid-base theories, and buffer systems to predict and interpret the behavior of chemical systems under varying conditions of pressure, temperature, and composition.	An	PSO-1,2,3
CO-2	Understand and apply the principles of electrochemistry to analyze conductance and electrode processes; perform and interpret conductometric and potentiometric titrations; explain the working of reference electrodes, concentration cells, and fuel cells; and utilize the Nernst equation to	An	PSO-1,2,3

	calculate cell potentials in various electrochemical systems.		
CO3	Understand the fundamental principles and types of catalysis, including enzyme catalysis with Michaelis-Menten kinetics; comprehend the laws and principles of photochemistry, and analyze photochemical reactions and phenomena such as fluorescence, phosphorescence, chemiluminescence, and photosensitization.	E	PSO-1,2,3
CO 4	Analyze and apply the concepts of solution chemistry and colligative properties to interpret behaviour of ideal, non-ideal, and partially miscible liquid systems; calculate concentration terms; solve numerical problems based on colligative properties; and explain phenomena like abnormal molecular masses, azeotropy, and critical solution temperature using experimental and theoretical principles.	C	PSO-1,2,3
CO 5	Design and conduct a series of physicochemical experiments involving conductometry, potentiometry, phase equilibria, adsorption, calorimetry, and partitioning to determine key analytical parameters and interpret data using relevant theoretical models.	C	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ESSENTIALS OF PHYSICAL CHEMISTRY

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO1	PO-1,6 PSO-1,2,3	An	F, C, M	L	-
2	CO2	PO-1,6 PSO-1,2,3	An	F, C, M	L	-
3	CO3	PO-1,6 PSO-1,2,3	E	F, C, M	L	-
4	CO4	PO-1,6 PSO-1,2,3	C	F, C, M	L	-

5	CO5	PO-1,2,6 PSO-1,2,3,4,5	C	F, C, P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 2	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 3	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 4	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 5	2	2	2	2	2	1	2	-	-	-	3	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓		✓	✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSCCHE202**				
Course Title	**CHEMICAL INSIGHTS: FROM SOIL TO PETROCHEMICALS**				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge 2. First & second semester DSCs (chemistry) offered by UoK (preferable)				
Course Summary	This course covers soil and water chemistry, electrochemistry, petrochemicals, instrumental methods of analysis, and practical physical chemistry experiments. Students gain insights into the chemical processes governing soil and water behaviour, industrial applications of electrochemistry and petrochemicals, and hands-on experience in various analytical techniques.				

Detailed Syllabus:

Module	Unit	Content	Hrs
	CHEMICAL INSIGHTS: FROM SOIL TO PETROCHEMICALS		**75**
I	**SOIL AND WATER CHEMISTRY**		**18**
	1	Soil – Composition, mineral matter in soil process of soil formation, weathering – physical (mention), chemical (detail) + biological (mention) Saline and alkaline soil (brief explanation) Rocks – different types (Igneous, sedimentary and Metamorphic)	5
	2	Analysis of lime stone (qualitative treatment only)	1
	3	Chemistry of salt-affected soils and amendments, soil pH, ECe, ESP, SAR and important relation	3
	4	Soil management and amendments. Chemistry and electrochemistry of submerged soils	2
	5	Water Analysis Water quality parameters COD, BOD, main quality characteristics of water (alkalinity, hardness, total solids and oxidation)	3
	6	Water treatment including chemical (Precipitation, aeration, ozonisation, chlorination) and physical methods of sterilization.	4
II	**ELECTRO CHEMISTRY**		**9**

	7	Transport number – definition, determination by Hittorf's method and moving boundary method, application of conductance measurements	2
	8	Conductometric titrations involving strong acid – strong base, strong acid – weak base, weak acid – strong base and weak acid – weak base	2
	9	EMF – Galvanic cells, measurement of emf, cell and electrode potential, IUPAC sign convention, Reference electrodes, SHE and calomel electrode	1
	10	Standard electrode potential, Nernst equation, anion and cation reversible electrodes, redox electrode with examples, quinhydrone electrode, glass electrode	2
	11	Concentration cell without transference, Potentiometric titration Fuel cells – H_2 – O_2 and hydrocarbon – O_2 type	2
III	**PETRO CHEMICALS**		**9**
	12	Introduction to crude oil, exploratory methods, constitution of crude oil, natural gas – constituents	2
	13	Distillation of crude oil, separation of natural gas and different fractions Meaning of terms such as ignition point, flash point, octane number	2
	14	Types of hydrocarbon fuels and their characteristics	2
	15	Cracking – catalytic cracking, hydro cracking, isomerization, reforming, sulphur, hydrogen, petroleum, coke and nitrogen compounds from petroleum	3
IV	**INSTRUMENTAL METHODS OF ANALYSIS**		**9**
	16	Spectral methods – Atomic Absorption Spectroscopy (AAS) principle, measurement, advantages, disadvantages, and applications	2
	17	Flame Emission Spectroscopy (FES) principle, measurement (single beam method) applications	2
	18	Thermal methods: Thermogravimetric analysis (TG) principle and method, Factors affecting thermogravimetric analysis, Application	3
	19	Determination of Surface tension- capillary rise and stalagmometer method, Viscosity- Poiseuille's equation, Determination of viscosity- Ostwald's viscometer, Refractive index determination by Abbe refractometer	2
V	**PRACTICALS: PHYSICAL CHEMISTRY EXPERIMENTS**		**30**
	A minimum of 5 practical experiments out of which at least one each from sections I and II must be performed and reported.		
	20	**I. Conductometry**	8
	21	1. Determination of cell constant 2. Conductometric titration of NaOH using HCl	
	22	**II. Potentiometry**	8
		3. Potentiometric titration of Fe^{2+} versus $Cr_2O_7^{2-}$ 4. Potentiometric titration of KMnO4 versus KI	
	23	**III. Surface tension:** 5. Determination of Surface tension of any three liquids 6. Surface tension of binary mixtures and determination of concentration of an unknown mixture	8

		IV. Viscosity: 7. Determination of viscosity of any three liquids 8. Viscosity of binary mixtures and determination of concentration of an unknown mixture	
	24	**V. Refractive index experiments:** 9. Determination of refractive indices of any three liquids 10. Refractive indices of KCl solutions of different concentrations and determination of concentration of unknown KCl solution	6

References

1. B.R Puri, L R Sharma K C Kalia, *Principles of Inorganic Chemistry*, Sobhanlal Nagin Chand & Co. New Delhi.
2. Manas Chanda, *Atomic structure and Chemical bonding in molecular spectroscopy*, Tata Mc Graw Hill.
3. J D Lee, *Concise Inorganic Chemistry*, ELBS.
4. Miller T. G. Jr., *Environmental Science*, Wadsworth publishing House, Meerut Odum.E.P.1971.
5. Odum, E.P. (1971) *Fundamentals of Ecology*. Third Edition, W.B. Saunders Co., Philadelphia
6. S. E. Manahan, *Environmental chemistry*, 1993, Boca Raton, Lewis publisher
7. *Environmental chemistry*, Sharma and Kaur, 2016, Krishna publishers
8. Puri, Sharma, Pathania *Principles of Physical Chemistry*
9. B. K. Sharma, *Instrumental methods of Chemical Analysis*
10. D.A Skoog, D M West, F J, Holler, S R Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brookes/Cole, Thomson Learning, Inc, USA, 2004
11. B. K. Sharma, *Soil and Noise pollution*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand and analyze the chemical and physical characteristics of soils and water, explain the processes involved in soil formation and weathering, classify different types of rocks and soils, interpret the chemistry of salt-affected and submerged soils, apply concepts of soil pH and salinity indicators, and evaluate water quality based on key parameters. The learner will also be able to suggest appropriate soil amendments and water treatment methods using chemical and physical techniques for sustainable environmental management.	An	PSO-1,2,3,4,5

CO-2	Understand and apply the principles of ionic conductance and electrochemical cells to interpret and analyze transport numbers, conductometric and potentiometric titrations, electrode potentials, and electrochemical energy conversion systems.	An	PSO-1,2,3,4,5
CO3	Understand the origin, composition, and processing of crude oil and natural gas; explain key petroleum refining techniques such as distillation, cracking, isomerization, and reforming; describe the characteristics of various hydrocarbon fuels; and interpret important fuel-related parameters such as ignition point, flash point, and octane number.	E	PSO-1,2,3,4,5
CO 4	Understand and explain the fundamental principles, measurement techniques, and applications of key analytical methods. Determine the physicochemical properties such as surface tension, viscosity and refractive index. Critically evaluate the advantages, limitations, and factors affecting the instrumental and thermal techniques and applying this knowledge to solve practical problems in chemical analysis and materials characterization.	C	PSO-1,2,3,5
CO 5	Develop proficiency in performing electrochemical, physicochemical, and optical property measurements of chemical systems; analyze experimental data to determine fundamental physical constants, concentrations, and properties of pure substances and mixtures; and interpret results in the context of solution behavior and intermolecular interactions.	C	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CHEMICAL INSIGHTS: FROM SOIL TO PETROCHEMICALS

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO- 1,6 PSO-1,2,3,4,5	An	F, C	L	-
2	CO-2	PO- 1,6 PSO-1,2,3,4,5	An	F, C	L	-
3	CO3	PO- 1,6 PSO-1,2,3,4,5	E	F, C	L	-

4	CO 4	PO- 1,2,3,6,7 PSO-1,2,3,5	C	F, C, P	L	-
5	CO 5	PO- 1,2,3,6,7 PSO-1,2,3,4,5	C	C, P, M	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of Cos with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	3	3	3	1	-	-	-	-	2	-	-
CO 2	3	3	3	3	3	1	-	-	-	-	2	-	-
CO 3	3	3	3	3	3	1	-	-	-	-	2	-	-
CO 4	3	3	2	-	2	1	2	2	-	-	2	2	-
CO 5	1	3	3	3	2	1	2	2	-	-	2	2	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of Cos to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4	✓		✓	✓
CO 5	✓		✓	✓

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSCCHE203**				
Course Title	**NATURAL PRODUCT CHEMISTRY**				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge 2. First & second semester DSCs (chemistry) offered by UoK (preferable)				
Course Summary	The course covers chromatography principles and applications, biochemistry of amino acids, proteins, and nucleic acids, analysis of oils, fats, alkaloids, vitamins, and terpenes, carbohydrate and natural polymer chemistry, and practical organic preparations and analytical techniques. Students gain comprehensive knowledge and practical skills in organic chemistry, biochemistry and analytical chemistry.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		NATURAL PRODUCT CHEMISTRY	**75**
I	**BIOINORGANIC CHEMISTRY**		**9**
	1	Metalloporphyrins – cytochromes – Chlorophyll - photosynthesis and respiration	3
	2	Haemoglobin and myoglobin, mechanism of O_2 – CO_2 transportation	2
	3	Nitrogen fixation, carbon fixation and carbon cycle	2
	4	Biochemistry of iron toxicity and nutrition, essential and trace elements in biological systems	2
II	**AMINO ACIDS, PROTEINS & NUCLEIC ACIDS**		**9**
	5	Classification and properties of amino acids, Synthesis of glycine, alanine and tryptophan	2
	6	Polypeptides and proteins, peptide linkage, peptide synthesis Primary, secondary, tertiary and quaternary structure of proteins, Test for proteins	3
	7	Enzymes – Characteristics, catalytic action, theory of enzyme catalysis – Michaelis – Menton theory- Co-enzymes	2

	8	RNA, DNA – their biological role, hydrolysis of nucleoproteins, elementary idea regarding the structure of nucleic acids Replication of DNA- Transcription and Translation - Genetic code	2
III	**OILS, FATS, ALKALOIDS, VITAMINS AND TERPENES**		**9**
	9	Oils and Fats: Occurrence and extraction-Analysis of oils and fats saponification value, iodine value and acid value	2
	10	Alkaloids: - Extraction and structural elucidation of conine and importance of quinine, morphine and codeine	3
	11	Terpenes: Classification- Isoprene and special isoprene rule-Isolation of essential oils citral and geraniol (No structural elucidation)	2
	12	Vitamins: - Classification and structure, functions and deficiency diseases (structures of vitamin A, B1 and C but no structural elucidation	2
IV	**CARBOHYDRATES AND NATURAL POLYMERS**		**18**
	13	Classification. Configuration- glyceraldehyde, erythrose, threose, ribose, 2-deoxy ribose, arabinose, glucose, fructose and mannose	2
	14	Preparation and properties of glucose and fructose	3
	15	Pyranoside structures of glucose and fructose, furanoside structure of fructose (structure elucidation not expected) Mutarotation and epimerization Properties and structure of sucrose. (structure elucidation not expected)	4
	16	Structure of starch and cellulose (Elementary idea only)	2
	17	Natural rubber – Isolation, vulcanisation - characteristics and applications	3
	18	Synthesis and applications of biodegradable polymers – PLA, PGA, PHBV, PHB, Nylon – 2 –nylon - 6	4
V	**PRACTICALS – Organic Preparations, Dyes, Food analysis, Drug analysis, Fertilizer analysis**		**30**
	19	**Section A (Any 3 Experiments from Section A are compulsory)** Organic preparation: 1. Acetylation of salicylic acid or aniline 2. Benzoylation of phenol or aniline 3. Nitration of Acetanilide or nitrobenzene 4. Halogenation: Bromination of acetanilide 5. Oxidation of benzaldehyde/Toluene/Benzyl chloride 6. Hydrolysis of ethyl acetate and benzamide 7. Methyl orange 8. Picric acid 9. Phenyl urea 10. Methylene blue Purification of organic compounds Purity of organic compounds – MP and BP Recrystallisation of organic compounds Preparation of dyes Preparation of aspirin TLC of simple organic compounds- cresol, napthol, nitrobenzene	15

	20	**Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add experiments)** 1. Dichrometric titrations: 2. Iodimetry and Iodometry 3. Complexometric titrations: 4. Complexometric Titration: Determination of calcium content in milk. 5. Precipitation Titration: Determination of salt content in potato chips 6. Estimation of saponification value of fats/oils. 7. Determination of hardness of water. 8. Determination of available chlorine in bleaching powder. 9. Redox Titration: Determination of Vitamin C Content in Tablets. 10. Complexometric Titration: Determination of Magnesium Content in Antacids. 11. Precipitation Titration: Determination of Chloride Content in Saline Solutions. 12. Redox Titration: Determination of Iron Content in Iron Supplements 13. Complexometric Titration: Determination of Zinc Content in Zinc Supplements. 14. pH meter: Determination of pH of Fertilizer Solution.	15

References

1. B. K. Sharma, *Instrumental methods of Chemical Analysis*.
2. D.A Skoog, D M West, F J, Holler, S R Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brookes/Cole, Thomson Learning, Inc, USA,2004
3. B. K. Sharma, *Industrial Chemistry*
4. Dr, U. Satyanarayana and Dr. U. Chakrapani, *Biochemistry*, Books and Allied (P) Ltd
5. J. L. Jain, Sunjay Jain, Nitin Jain, *Fundamentals of Biochemistry*, S. Chand & Co. Ltd.
6. R K Murray, DK Granner, PA Mayers, VW Rodwell, *Harper's Biochemistry*, Prentiace- Hall International Editions.
7. I. L Finar, *Organic Chemistry – Vol. 1*
8. *Vogel's Textbook of Practical Organic Chemistry* Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R., 5th ed., Pearson Education.
9. *Practical Organic Chemistry,* Mann, F.G.; Saunders, B.C., 4th ed., Pearson Education.
10. *Comprehensive Practical Organic Chemistry – Preparation and Quantitative Analysis* Ahluwalia, V.K.; Aggarwal, R. Universities Press.
11. *Advanced Practical Organic Chemistry,* Vishnoi, N.K., 3rd ed., Vikas Publishing House, New Delhi, 2010.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand and analyze the structure, function, and biochemical significance of metalloporphyrins; explain the mechanisms of oxygen and carbon dioxide transport in biological systems; describe key biochemical processes including photosynthesis, respiration, nitrogen fixation, and carbon fixation within the carbon cycle; and evaluate the roles of essential and trace elements, particularly iron, in nutrition and toxicity in living organisms.	An	PSO-1,2,3
CO-2	Understand the classification, properties, and synthesis of amino acids; explain the structure and function of polypeptides and proteins including structure; describe peptide linkage and methods of peptide synthesis; analyze the characteristics and catalytic mechanisms of enzymes with emphasis on Michaelis-Menten kinetics and coenzymes; comprehend the biological roles and structural features of RNA and DNA; and demonstrate foundational knowledge of nucleoprotein hydrolysis, DNA replication, transcription, translation, and the genetic code.	An	PSO-1,2,3
CO 3	Understand the occurrence, extraction, and analysis of oils, fats, alkaloids, terpenes, and vitamins, including their classification, key properties, biological significance, and related deficiency diseases.	E	PSO-1,2,3
CO 4	Analyze and classify carbohydrates based on their stereochemistry and configurations, understand the preparation, structural variations, and properties of key monosaccharides and disaccharides, explain the elementary structure and functional roles of polysaccharides and natural polymers, and evaluate the synthesis, characteristics, and applications of biodegradable and synthetic polymers in modern materials science.	C	PSO-1,2,3
CO 5	Develop advanced practical skills in organic synthesis, purification, and qualitative analysis, alongside quantitative titrimetric and instrumental techniques for the determination of chemical composition and purity in diverse real-world samples, thereby enhancing analytical reasoning and problem-solving abilities in chemical experimentation.	C	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: NATURAL PRODUCT CHEMISTRY

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO-1,6 PSO-1,2,3	An	F, C	L	-
2	CO-2	PO-1,6 PSO-1,2,3	An	F, C	L	-
3	CO 3	PO-1,6 PSO-1,2,3	E	F, C	L	-
4	CO 4	PO-1,2,6 PSO-1,2,3	C	C, P	L	-
5	CO 5	PO-1,2,3,6 PSO-1,2,3,4,5	C	C, P, M	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	3	-	-	1	-	-	-	-	2	-	-
CO 2	3	3	3	-	-	1	-	-	-	-	2	-	-
CO 3	3	3	3	-	-	1	-	-	-	-	2	-	-
CO 4	3	3	3	-	-	1	1	-	-	-	3	-	-
CO 5	2	3	3	2	3	1	1	2	-	-	3	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓		✓	✓
CO 3	✓	✓		✓
CO 4	✓		✓	✓
CO 5	✓		✓	✓

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSCCHE204**				
Course Title	**CHEMISTRY UNVEILED: EVERYDAY APPLICATIONS**				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge 2. First & second semester DSCs (chemistry) offered by UoK (preferable)				
Course Summary	The course covers textile chemistry, food chemistry, chemistry and agriculture, basics of perfumery, cosmetics, paper manufacturing, and drug classification. Practical sessions encompass dyes, food analysis, drug analysis, and fertilizer analysis, offering hands-on experience.				

Detailed Syllabus:

Module	Unit	Content CHEMISTRY UNVEILED: EVERYDAY APPLICATIONS	Hrs 75
I	**TEXTILE CHEMISTRY**		**9**
	1	Definition, Requisite of a true dye, Types of fibres: structure features of fibres (Cotton, wool, silk, cellulose acetate, polyamide, polyesters)	3
	2	Basic operations in dyeing process (preparation of the fibre, preparation of dye bath, application of dye and finishing), Various methods of dyeing (direct dyeing, vat dyeing, Mordant Dyeing, and disperse dyeing).	3
	3	Witt's theory of colour and constitution, classification of dyes based on their functional group- i) Nitro ii) Nitroso and iii) Azo, Pollution problem due to dye industry.	3
II	**FOOD CHEMISTRY**		**9**
	4	Food additives – definition. Preservatives (examples), Food colours - permitted and non-permitted (examples), Toxicology. Flavours - natural and synthetic (examples),	3
	5	Artificial sweeteners (examples), Emulsifying agents (examples), Antioxidants (examples), Leavening agents (examples) and Flavour enhancers (examples). Importance of food additives.	3
	6	Soft drinks - formulation and health effects. Health drinks.	1

	7	Fast foods and junk foods and their health effects. Food adulteration (with examples). Food laws and standards. Food Safety and Standards Act, 2006.	2
III	**CHEMISTRY AND AGRICULTURE**		**9**
	8	Fertilizers – Introduction. Types of fertilizers - Natural, synthetic, mixed, NPK fertilizers (examples). Excessive use of fertilizers and its impact on the environment. Bio-fertilizers. Plant growth hormones.	4
	9	Pesticides - Introduction. Classification - Insecticides, Fungicides, Herbicides.	3
	10	Excessive use of pesticides - Environmental hazards. Bio pesticides.	2
IV	**PERFUMERIES, COSMETICS, PAPERS, & DRUGS**		**18**
	11	Perfumes: Definition and history of perfumery - Importance of perfumes in society and culture, Classification of fragrance ingredients (natural vs. synthetic – with examples), Chemical structure and properties of key fragrance compounds (terpenes, aldehydes, ketones, esters, etc. with examples) Relationship between chemical structure and fragrance.	5
	12	Cosmetics - Introduction. General formulation of different types of cosmetics – Dental cosmetics, Shampoos, Hair dyes, Skin products (creams and lotions, lipstick, perfumes, deodorants and antiperspirants), Bath oil, Shaving cream and Talcum powder. Toxicology of cosmetics.	5
	13	Paper – Introduction. Paper manufacture (basic idea only). Weight and size of paper. Types of paper - News print paper, writing paper, paperboards, cardboards. Environmental impact of paper. International recycling codes, and symbols for identification of paper, plastic and metals. Natural and synthetic dyes in paper industry with examples (elementary idea only).	5
	14	Classification of drugs - Analgesics, Antipyretics, Antihistamines, Antacids, Antibiotics and Antifertility drugs with examples. Psychotropic drugs - Tranquilizers, Antidepressants and Stimulants with examples. Drug addiction and abuse. Prevention and treatment.	3
V	**PRACTICALS – Organic Preparations, Dyes, Food analysis, Drug analysis, Fertilizer analysis**		**30**
	15.	**Section A (Any 5 Experiments from Section A are compulsory)** Organic preparation: 1. Acetylation of salicylic acid or aniline 2. Benzoylation of phenol or aniline 3. Nitration of Acetanilide or nitrobenzene 4. Halogenation: Bromination of acetanilide 5. Oxidation of benzaldehyde/Toluene/Benzyl chloride 6. Hydrolysis of ethyl acetate and benzamide 7. Methyl orange 8. Picric acid 9. Phenyl urea 10. Methylene blue	15

	16.	**Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add experiments)** 1. Dichrometric titrations: 2. Iodimetry and Iodometry 3. Complexometric titrations: 4. Complexometric Titration: Determination of calcium content in milk. 5. Precipitation Titration: Determination of salt content in potato chips 6. Estimation of saponification value of fats/oils. 7. Determination of hardness of water. 8. Determination of available chlorine in bleaching powder. 9. Redox Titration: Determination of Vitamin C Content in Tablets. 10. Complexometric Titration: Determination of Magnesium Content in Antacids. 11. Precipitation Titration: Determination of Chloride Content in Saline Solutions. 12. Redox Titration: Determination of Iron Content in Iron Supplements 13. Complexometric Titration: Determination of Zinc Content in Zinc Supplements. 14. pH meter: Determination of pH of Fertilizer Solution.	15

References

1. *Text Book of Organic Chemistry*: B.S. Bahl and G.D. Tuli, S. Chand Publication, New Delhi.
2. *A Text Book of Engineering Chemistry*, S.S. Dara and Suresh Umare, S. Chand Publication, New Delhi.
3. *A Text Book of Basic and Applied Chemistry*, P.C. Jain and Monica Jain.
4. *Text Book of Organic Chemistry* by J. L. Finar, Longman Publication.
5. *Synthetic Dyes* by G R Chatwal, Himalaya Publishing House, New Delhi.
6. *Organic Chemistry of Natural Products* Vol. I and II, by G. R. Chatwal, Himalaya Publishing House, New Delhi.
7. *Food Science*, B. Sreelakshmi, New Age International, New Delhi.
8. *Soil Fertility and Fertilizers,* S.L. Tisdale; W. L. Nelson and J. D. Beaton, Macmillan Publishing Company, New York, 1990.
9. *Chemistry of Pesticides*, K. H. Buchel, John Wiley & Sons, New York, 1983.
10. *Insecticides, Pesticides and Argo based Industries*, P.C. Pall; K. Goel and R.K. Gupta.
11. *Perfumes, Cosmetics, Soaps* Vol. I, II and III by W. A. Poucher, Ninth Edition, Chapman and Hall Publication.
12. *New Cosmetic Science* by Takeo Mitsui, Elsevier.
13. *Medicinal Chemistry*, D. Sriram and P. Yogeeswari, 2nd edn. Pearson, 2011.
14. *Synthetic Drug* by G R Chatwal and Anand, Himalaya Publishing House, New Delhi.

15. *Vogel's Textbook of Practical Organic Chemistry* Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R., 5th ed., Pearson Education.
16. *Practical Organic Chemistry,* Mann, F.G.; Saunders, B.C., 4th ed., Pearson Education.
17. *Comprehensive Practical Organic Chemistry – Preparation and Quantitative Analysis* Ahluwalia, V.K.; Aggarwal, R. Universities Press.
18. *Advanced Practical Organic Chemistry,* Vishnoi, N.K., 3rd ed., Vikas Publishing House, New Delhi, 2010.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Critically analyze the structural characteristics of natural and synthetic fibers, understand and apply various dyeing techniques and processes, evaluate dye classifications based on chemical functionality and Witt's theory of color, and assess the environmental impact of dye industry pollution, enabling informed decisions in textile chemistry and sustainable practices.	An	PSO-1,2,3,4
CO-2	Critically analyze the types, functions, and safety aspects of food additives—including preservatives, colors, flavors, sweeteners, emulsifiers, antioxidants, leavening agents, and flavor enhancers—evaluate the formulation and health impacts of soft drinks, health drinks, fast and junk foods, identify common food adulterants, and interpret relevant food laws and standards, to ensure informed decisions in food quality and safety management.	E	PSO-1,2,3,4
CO-3	Critically analyze the types, applications, and environmental impacts of fertilizers and pesticides, including natural, synthetic, bio-fertilizers, and bio-pesticides, and evaluate sustainable practices for their responsible use in agriculture.	An	PSO-1,2,3,4
CO-4	Critically analyze the chemistry, formulation, classification, and societal impact of perfumes, cosmetics, paper, and drugs—understanding their chemical properties, applications, toxicology, environmental considerations, and the role of synthetic and natural components in these everyday materials and pharmaceuticals.	C	PSO-1,2,3,4
CO-5	Develop advanced practical skills in organic synthesis, qualitative and quantitative analytical techniques, including	C	PSO-1,2,3,4,5

	titrations and instrumental methods, enabling them to accurately perform and interpret a wide range of chemical preparations and estimations relevant to real-world applications.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CHEMISTRY UNVEILED: EVERYDAY APPLICATIONS

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO-1,3,6 PSO-1,2,3,4	An	F, C, P	L	-
2	CO-2	PO-1,3,6 PSO-1,2,3,4	E	C, P, M	L	-
3	CO-3	PO-1,3,6 PSO-1,2,3,4	An	C, P, M	L	-
4	CO-4	PO-1,3,6 PSO-1,2,3,4	C	C, P, M	L	-
5	CO-5	PO-1,3,6 PSO-1,2,3,4,5	C	P, M	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	3	2	-	2	-	2	-	-	2	-	-
CO 2	3	3	3	2	-	2	-	2	-	-	2	-	-
CO 3	3	3	3	2	-	2	-	2	-	-	2	-	-
CO 4	3	3	3	2	-	2	-	2	-	-	2	-	-
CO 5	2	2	3	2	3	2	-	3	-	-	3	-	3

Correlation Levels:

Level	Correlation

-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4	✓	✓		✓
CO 5	✓		✓	✓

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSCCHE205**				
Course Title	**BIOMOLECULES AND BIOPHYSICAL CHEMISTRY-II**				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge 2. First & second semester DSCs (chemistry) offered by UoK (preferable)				
Course Summary	This course includes topics of enzymes, lipids, kinetics of reactions, metabolism of compounds and bioenergetics. Students can learn about enzymes, classification of enzymes, importance of enzymes and their role in life. This course also discusses the chemistry of lipids and kinetics of reactions. Students learnt about metabolism of various compounds, and fundamentals of bioenergetics.				

Detailed Syllabus:

Module	Unit	Content BIOMOLECULES AND BIOPHYSICAL CHEMISTRY-II	Hrs 75
1	**INTRODUCTION TO ENZYMES & LIPIDS**		**18**
	1	Enzymes – Chemical nature and Features of active site. Enzyme Specificity – Stereo, reaction, substrate and broad specificity. Enzyme Commission system of classification and nomenclature of enzymes: six major classes of enzymes with one example each.	3
	2	Coenzymes and their functions - NAD, NADP+, FAD, FMN, lipoic acid, pyridoxal phosphate, biotin and cyanocobalamin. Ribozymes, Measurement and expression of enzyme activity, Definition of IU, katals, enzyme turnover number.	3
	3	Isoenzymes- Lactate dehydrogenase Applications of enzymes – Enzymes as therapeutic agents, as analytical reagents, immobilized enzymes	3
	4	Lipids: Definition, basic ideas about the biochemical functions of lipids. Classification of lipids with examples, classification of fatty acids, physical and chemical properties of fatty acids.	2

	5	Structure of the following fatty acids- stearic acid, oleic acid, linoleic acid, arachidonic acid. Structure of triacylglycerol.	2
	6	Saponification number, acid number and iodine number of fats. Essential and non-essential fatty acids with examples	2
	7	Compound lipids: membrane lipids- Structure and functions of phospholipids- phosphatidic acid, lecithin, cephalin, and phosphatidyl serine, Functions of Sphingolipids.	2
	8	Steroids: Structure and functions of cholesterol and ergosterol	1
II	**CHEMICAL KINETICS**		**9**
	9	Rate of reactions, various factors influencing rate, order, molecularity, zero, first, second, third order reactions. Rate determining step. Derivation of first order kinetics - fractional life time, units of rate constants	3
	10	Influence of temperature on reaction rates, Arrhenius equation, Calculation of Arrhenius parameters.	2
	11	Factors affecting enzyme catalysed reactions - effect of substrate concentration, enzyme concentration, temperature, pH and activators. Mechanism of Enzyme action - Activation energy, Interaction between enzyme and substrate- lock and key model, induced fit model. Enzyme kinetics - Km and its significance, Michaelis Menton equation (without derivation), Lineweaver- Burk plot. Significance of Km and Vm values.	4
III	**INTRODUCTION TO METABOLISM**		**9**
	11	Metabolism- catabolism and anabolism Metabolism of carbohydrates – Glycolysis and citric acid cycle, Electron transport chain and Oxidative phosphorylation.	3
	12	Glycogenesis and glycogenolysis, Gluconeogenesis (Mention only) .	1
	13	Metabolism of lipids - Metabolism of triglycerides, Outline study of β-oxidation of saturated and unsaturated fatty acids	3
	14	Metabolism of amino acids – Proteolysis, Urea cycle.	2
IV	**BIOENERGETICS**		**9**
	15	Basic concepts – System – surroundings – open, closed and isolated systems – Isothermal– isochoric and isobaric process.	3
	16	Biochemical thermodynamics, first and second law of thermodynamics, Enthalpy, Entropy and Free energy. Criteria for reversible and irreversible process - Gibbs free energy equation.	3
	17	Relationship between standard free energy change and equilibrium constant. Standard free energy changes at pH 7.0 (ΔG'), additive nature of ΔG', ATP as universal currency of free energy in biological systems. Photosynthesis – solar energy harvesting	3
V	**PRACTICAL- Physical chemistry experiments & Organic experiments**		**30**
	18	**Section A: Organic Quantitative Analysis: 4 Experiments from Section A are compulsory** 1. Saponification number of fats	15

		2. Acid number of fats 3. Iodine number of fats 4. Separation of photosynthetic pigments by TLC 5. Estimation of total chlorophyll, chlorophyll a and chlorophyll b pigments from the leaves.	
	19	**Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add experiments)** 1. Kinetics a. Determination of rate constant of hydrolysis of methyl acetate b. Determination of rate constant of saponification of ethyl acetate. c. Kinetics of dye degradation using spectrophotometer 2. Preparation of acidic and basic buffer 3. Measurement of pH of buffers using pH meter 4. Heat of neutralisation of strong acid – strong base titration.	15

References:

1. Dr. U. Satyanarayana, Dr. U. Chakrapani, *Biochemistry*, Books and Allied (P) Ltd
2. J. L. Jain, Sunjay Jain, Nitin Jain, *Fundamentals of Biochemistry*, S. Chand & Co. Ltd.
3. RK Murray, DK Granner, PA Mayers, VW Rodwell, *Harper's Biochemistry*, Prentiace-Hall International Editions.
4. Sharma, Madan and Pahania, *Principles of Physical Chemistry*, Vishal Publishing Co.
5. J.D. Lee, *Concise Inorganic Chemistry*.
6. Puri, Sharma and Kalia, *"Inorganic Chemistry"*.
7. Arthur I. Vogel, B. S. Furniss, *Vogel's Textbook of practical organic chemistry,* 5th ed., Longman Scientific & Technical, London, 1996.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Critically analyze the chemical nature, classification, specificity, catalytic function, and applied aspects of enzymes and lipids, including structural and functional roles of coenzymes, isoenzymes, membrane lipids, and steroids, integrating biochemical principles with real-world applications.	An	PSO-1,2,3
CO-2	Critically analyze the kinetics and mechanisms of chemical and enzyme-catalyzed reactions by evaluating the influence of various factors on reaction rates, interpreting kinetic parameters, and applying models such as the Arrhenius equation and Michaelis-	An	PSO-1,2,3

	Menten kinetics to real-world chemical and biochemical systems.		
CO3	Evaluate and integrate the biochemical pathways of carbohydrate, lipid, and protein metabolism—including glycolysis, the citric acid cycle, oxidative phosphorylation, β-oxidation, and the urea cycle—to explain energy production and metabolic regulation in living systems.	E	PSO-1,2,3
CO 4	Critically analyze and apply the principles of thermodynamics, including energy transformations, free energy changes, and equilibrium in biochemical systems, with special emphasis on ATP metabolism and solar energy capture in photosynthesis.	C	PSO-1,2,3
CO 5	Develop advanced analytical and instrumental skills to quantitatively evaluate organic compounds, investigate reaction kinetics, and apply physicochemical principles to study biochemical systems and environmental processes.	C	PSO-1,2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: BIOMOLECULES AND BIOPHYSICAL CHEMISTRY-II

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO-1,6 PSO-1,2,3	An	F, C	L	-
2	CO-2	PO-1,6 PSO-1,2,3	An	F, C	L	-
3	CO3	PO-1,6 PSO-1,2,3	E	F, C	L	-
4	CO 4	PO-1,6 PSO-1,2,3	C	F, C	L	-
5	CO 5	PO-1,6 PSO-1,2,3	C	F, C	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 2	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 3	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 4	3	3	2	-	-	1	-	-	-	-	2	-	-
CO 5	3	3	2	-	-	1	-	-	-	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSCCHE206**				
Course Title	**GENERAL CHEMISTRY III**				
Type of Course	**DSC**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge 2. First & second semester DSCs (chemistry) offered by UoK (preferable)				
Course Summary	The course delves into the chemistry behind drugs, food additives, energy production and storage, fertilizers, explosives, and polymers. Through theoretical exploration and practical experiments, students will gain a comprehensive understanding of the synthesis, properties, and applications of these substances, contributing to fields such as medicine, agriculture, energy, and materials science. The course emphasizes the interdisciplinary nature of chemistry and its significance in addressing societal needs and challenges related to health, food safety, energy, and environmental sustainability.				

Detailed Syllabus:

Module	Unit	Content GENERAL CHEMISTRY III	Hrs 75
I	**CHEMISTRY OF DRUGS & FOOD ADDITIVES**		**18**
	1	Classification of drugs- analgesic, antipyretic, antibiotic, hypnotics, sulpha drugs, antacids, antimalarials with examples – Mode of action of sulpha drugs	6
	2	Structure of aspirin, sulphaguanidine, Paracetamol Drugs of plant origin- anticancer compounds from plants (elementary idea only)	3
	3	Food additives – definition. Preservatives (examples), Food colours - permitted and non-permitted (examples), Toxicology. Flavours - natural and synthetic (examples)	3
	4	Artificial sweeteners (examples), Emulsifying agents (examples), Antioxidants (examples), Leavening agents (examples) and Flavour enhancers (examples). Importance of food additives.	3

	5	Soft drinks - formulation and health effects. Health drinks. Fast foods and junk foods and their health effects. Food adulteration (with examples). Food laws and standards. Food Safety and Standards Act, 2006.	3
II	**CHEMISTRY FOR ENERGY PRODUCTION & STORAGE**		**9**
	6	Primary and secondary batteries, battery components and their role	2
	7	Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery.	4
	8	Fuel cells, Solar cell and polymer cell.	3
III	**FERTILIZERS & EXPLOSIVES**		**9**
	9	Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.	6
	10	Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.	3
IV	**POLYMERS**		**9**
	11	Introduction. Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions.	3
	12	Typical examples: Polyethylene, polypropylene, PVC, phenol-formaldehyde and melamine formaldehyde resins, polyamides (nylons) and polyesters.	4
	13	Natural rubber: structure, latex processing methods, vulcanization and uses.	
	14	Synthetic rubbers: SBR, nitrile rubber and neoprene. Biodegradability of polymers, environmental hazards. Recycling of plastics.	2
V	**PRACTICALS**		**30**
	15	**Section A:** **I. REACTIONS OF THE FOLLOWING CATIONS:** Hg^{+}, Pb^{2+}, Ag^{+}, $Hg^{2+,}$ Bi^{3+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Mn^{2+}, Zn^{2+}, Ni^{2+}, Cd^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+} and NH_4^{+}. **II. SYSTEMATIC ANALYSIS OF TWO CATIONS IN A MIXTURE** The cations must be provided in solutions. A student must analyze **at least 5 mixtures** containing two cations each. **OR** **Section A: Organic Qualitative Analysis (Any 5 compounds with different functional groups are compulsory)** Systematic analysis with a view to identify the organic compound (aromatic – aliphatic, saturated – unsaturated, detection of elements and detection of functional groups) – polynuclear hydrocarbons, alcohols, phenols, halogen compounds, nitro compounds, amino compounds, aldehydes, ketones, carboxylic acids, amides, urea, thiourea and esters. Only monofunctional compounds are to be given.	15

		(Make sure that the practicals conducted for second minor students are different from that of first minor DSC)	
	16	**Section B: OPEN ENDED PRACTICALS (Any 3 experiments)** 1. Test for the presence of food additives in common food items by spot tests or chromatography techniques and known food additives as reference standards. 2. Measurement of the acidity of soft drinks by pH indicator strips or a pH meter. 3. Investigation of the antioxidant properties of different food items calorimetrically using a known antioxidant (e.g., vitamin C) as standard. 4. Detection of common adulterants in food products such as starch in milk, synthetic colors in spices, or urea in edible oils. 5. Construction of simple galvanic cell. 6. Measurement of pH of solutions prepared from different fertilizers. **(May be selected from the list or the teacher can add experiments)**	15

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1. D. Sriram and P. Yogeeswari, *Medicinal Chemistry* 2nd edn. Pearson, 2011.
2. G R Chatwal and Anand, *Synthetic Drug* Himalaya Publishing House, New Delhi.
3. G. R. Chatwal, *Organic Chemistry of Natural Products* Vol. I and II, Himalaya Publishing House, New Delhi.
4. B. Sreelakshmi, *Food Science,* New Age International, New Delhi.
5. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
6. P. C. Jain & M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
7. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
8. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.
9. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
10. S.L. Tisdale; W. L. Nelson and J. D. Beaton, *Soil Fertility and Fertilizers,* Macmillan Publishing Company, New York, 1990.
11. K. H. Buchel, *Chemistry of Pesticides,* John Wiley & Sons, New York, 1983.
12. V.R. Gowarikar, N.V. Viswanathan, J. Sreedhar, *Polymer Science*, 2nd edn., New Age International Pvt. Ltd., 2015.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze the classification, structure, and mechanism of drugs	An	PSO-1,2

	and food additives, analyze their roles, sources, and health impacts, and interpret food safety regulations including the Food Safety and Standards Act, 2006, to develop an informed understanding of public health and chemical safety.		
CO-2	Analyze the construction, components, working principles, and performance characteristics of primary and secondary batteries, including fuel cells, solar cells, lithium-based and polymer cells, with emphasis on their electrochemical mechanisms and applications.	An	PSO-1,2,3,4
CO-3	Evaluate the chemical principles, manufacturing processes, and applications of major industrial fertilizers and explosives, including their structural basis, reactivity, and role in agricultural and defense technologies.	E	PSO-1,2,3,4
CO-4	Evaluate the classification, synthesis, structural characteristics, and applications of natural and synthetic polymers—including rubbers and resins—while evaluating their environmental impact, biodegradability, and strategies for sustainable management through recycling.	C	PSO-1,2,3,4
CO-5	Develop the ability to systematically identify inorganic and organic compounds through qualitative analysis, apply analytical techniques in open-ended experimental contexts related to real-world chemical and environmental problems, and interpret data to draw meaningful scientific conclusions.	C	PSO-1,2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: GENERAL CHEMISTRY III

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO-1,6 PSO-1,2	An	F, C	L	-
2	CO-2	PO-1,6 PSO-1,2,3,4	An	F, C, P	L	-
3	CO-3	PO-1,6 PSO-1,2,3,4	E	C, P	L	-

4	CO-4	PO-1,6 PSO-1,2,3,4	C	C, P	L	-
5	CO-5	PO-1,6 PSO-1,2,3,4	C	C, P	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	3	2	-	-	-	1	-	-	-	-	2		
CO 2	2	3	3	1	-	1	-	-	-	-	2		
CO 3	2	3	3	1	-	1	-	-	-	-	2		
CO 4	2	3	3	1	-	1	-	-	-	-	2		
CO 5	1	2	3	2	-	1	-	2	-	-	2		

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓		✓	✓
CO 3	✓	✓		✓
CO 4	✓		✓	✓
CO 5	✓	✓		✓

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSECHE200**				
Course Title	**ENVIRONMENTAL CHEMISTRY I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical Per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	1. Fundamental concept of Environmental Chemistry 2. Terminology associated with Environment				
Course Summary	This course provides students with the knowledge of ecosystem and the different types of pollution caused by human activities. This course enlightens the students about the need to protect and conserve our environment for future generation. The course also highlights the green protocols and methodology being adopted for preserving the Environment.				

Detailed Syllabus:

Module	Unit	Content	Hours
		ENVIRONMENTAL CHEMISTRY I	
I	**ENVIRONMENT AND ITS COMPONENTS**		**9**
	1	Introduction, concepts and scope of environmental chemistry	2
	2	components of environment – biotic, abiotic and energy components	1
	3	Environmental segments- atmosphere, hydrosphere, lithosphere and biosphere-Structure and its composition	3
	4	General Concepts of biological cycles – carbon cycle, nitrogen cycle, and oxygen cycle	2
	5	Environmental perspectives, environment and society	1
II	**ECOLOGY AND ECOSYSTEM**		**9**
	6	Ecology-elementary idea. Food chain- grazer and detritus food chain. Food web. Ecological pyramid.	3
	7	Ecosystem- concept, components, function and classification	2
	8	Productivity in an ecosystem- primary and secondary productivity	1
	9	Biodiversity, sustainable ecosystem.	1
	10	Population and environment: Human population and distribution, urbanization	2
III	**RESOURCES-TYPES AND CLASSIFICATION**		**9**

	11	Natural Resources-classification, Water resources, Forest resources, Land resources, Mineral resources, Energy resources	2
	12	Renewable and non-Renewable energy resources. Renewable energy resources - bio fuel & biomass energy, hydro power, Solar energy Wave energy and Tidal Energy-Mention only	3
	13	Nonrenewable energy resources - nuclear fuels and fossil fuels	1
	14	Hydrogen as a next generation fuel	1
	15	Conservation of natural resources. Future energy resources. Sustainable use of resources	2
IV	**ENVIRONMENTAL POLLUTION, ETHICS AND LAWS**		**18**
	16	Pollution- definition and its classification. Pollutants, classification of pollutants based on source and physical state	4
	17	Causes, effect and control measures of thermal pollution, nuclear pollution, marine pollution and Industrial pollution- Cement, sugar, paper industry, thermal and nuclear power plants	5
	18	Environmental laws-Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Rio declaration, Montreal protocol, Kyoto Protocol-Principles	4
	19	Environmental ethics: Issues and possible solutions	1
	20	Environmental audit -Types Environmental management-objectives and components.	4
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc**		**15**
	21	Introduction to Environmental Components and segments	
	22	Concept of biological cycles and Food chain	
	23	Classification of Natural Energy Resources and its conservation	
	24	Classification of Pollutants and Types of Pollution	
	25	Introduction to environmental laws and legislation	

References

1 *Introduction to Environmental Chemistry*, Seventh Edition, New Age International Publishers
2 Gray W. van Loon & Stephen J. Duffy, *Environmental Chemistry*: A Global Perspective, Oxford University Press
3 H. Kaur, *Environmental Chemistry*, Pragati Prakashan
4 V.K Ahluwalia, *Environmental Chemistry*, Second Edition, Ane Books Pvt. Ltd.
5 Ronald A. Bailey, Herbert M. Clark, James P. Ferris, Sonja Krause, Robert L. Strong, *Chemistry of the Environment*, Second Edition, Academic Press
6 Asim K. Das, *Environmental Chemistry with Green Chemistry*, Books and Allied (P) Ltd.
7 G S Sodhi, *Fundamentals Environmental Chemistry*, Second Edition, Narosa Publishing House.

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO1	Help to understand concept of Environmental chemistry Environmental components, Environmental segments and various biogeochemical cycles and investigate the relationship of society with environment.	An	1,3
CO2	Help students to study the dynamics of ecosystem including food chains, explore the importance of biodiversity and their need to conserve the biodiversity	E	1,3
CO3	Develop an understanding of various resources and principles undertaken for the conservation of energy resources	C	1,2.3
CO4	Identifying the sources and types of environment pollution namely air pollution, water pollution, soil pollution Industrial pollution and discussed about Environmental Laws, Ethics and audit	An	1,3
CO5	Design sustainable solutions by integrating knowledge of environmental components, biological cycles, energy resource conservation, pollution control, and environmental legislation to address real-world ecological challenges.	C	1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ENVIRONMENTAL CHEMISTRY I

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO-1,3 PO-1,2	An	F, C	L	
2	CO-2	PSO-1,3 PO-1,2	E	C	L	
3	CO-3	PSO-3 PO-1,2	C	F, C	L	
4	CO-4	PSO-1,3 PO-1,2	An	F, C	L	
5	CO-5	PSO-1,3	C	F	T	

		PO-1,2				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3	-	2	-	-	3	2	-	-	-	-	-	-
CO 2	2	-	3	-	-	2	2	-	-	-	-	-	-
CO 3	-	3	-	-	-	2	3	-	-	-	-	-	-
CO 4	3	-	2	-	-	2	2	-	-	-	-	-	-
CO 5	3	-	3	-	-	3	3	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓			✓
CO 5		✓	✓	

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSECHE201**				
Course Title	**CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY- I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	1. Students should possess critical thinking skills to evaluate different energy resources objectively and analyze their advantages, disadvantages, and impacts. 2. Proficiency in using technology and understanding basic engineering principles will be helpful, especially when studying energy production technologies and their efficiency.				
Course Summary	This course aims to thoroughly understand diverse energy resources, their characteristics, and associated advantages and disadvantages, facilitating informed decision-making in energy production and consumption. By exploring innovative technologies and critically evaluating energy strategies, students develop skills to address real-world environmental challenges and promote sustainable energy practices in various sectors.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY- I	**60**
I	**NON - SUSTAINABLE AND NON- RENEWABLE ENERGY SYSTEMS**		**9**
	1	Non-sustainable and non-renewable energy systems. Classification of non-sustainable energy sources, significance of fossil fuels and nuclear energy.	2
	2	Fossil fuels and its importance; Coal, petroleum, Natural gas; mitigating environmental impacts, and promoting energy security and resilience	3
	3	Basics of nuclear energy, nuclear forces, isotopes, and radioactivity, Type of radiations and their properties	1
	4	Nuclear fission and fusion reactions, nuclear power plant, nuclear fuel cycle, nuclear safety and regulations	3
II	**CONVENTIONAL ENERGY SOURCES AND ENVIRONMENTAL CONSEQUENCES**		**9**

	5	Environmental pollution associated with energy generation from non-renewable sources and its consumption.	1
	6	Fossil fuels and air pollution. Greenhouse effect, Global warming, Carbon foot print- measures to reduce carbon foot print, Concept of carbon neutrality.	3
	7	Radioactive waste management, nuclear accidents – (two specific incidents-Fukushima and Chernob) and their environmental impacts, safety concerns related to nuclear energy production.	3
	8	Introduction to sustainable energy: Global energy challenges and need for sustainability and renewability.	2
III	**BASIC CONCEPTS OF ENERGY RESOURCES**		**9**
	9	Introduction to Renewable Energy- Definition. Renewable Energy sources switching, Difference between Renewable & Non-renewable sources, Main sources – solar, wind, tidal, biomass, geothermal, Applications	2
	10	Brief descriptions of solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy Hydrogen as a source of renewable energy- Introduction to hydrogen economy. Fuel cell – hydrogen- oxygen fuel cell.	3
	11	Green energy and zero energy concept. Renewable energy sources, Energy conservation principle, Measurement of Industrial energy efficiency, Transportation efficiency and alternative fuels	2
	12	Energy storage technologies. Future trends in energy storage systems, Environmental impact of energy extraction, production, and consumption.	1
	13	Environmental impact and Policy regulation, Environmental and social impacts.	1
IV	**ENERGY ASSESSMENT AND EVALUATION**		**18**
	14	Introduction to Energy Audit, Assessment, and Survey-Definition and scope of energy audits, Importance of energy management in laboratories and chemical industries, Role of energy assessment in sustainable development, Basic components of an energy survey: data collection, energy flow analysis, consumption trends	6
	15	Types of Energy Audits and Related Practices; Walk-through Audit: Initial assessment, quick survey, spotting obvious inefficiencies Preliminary Energy Audit: Intermediate level data analysis, identification of major energy-saving opportunities Detailed Energy Audit: Comprehensive analysis with monitoring instruments, ROI calculation, in-depth diagnostics Retro-commissioning: Re-optimization of existing building systems Industrial Energy Assessment: Evaluation of energy use in chemical processes and industrial equipment Renewable Energy Assessment: Feasibility and impact of solar, wind, and bioenergy alternatives	6

		Recommended Practices: Use of energy performance indicators, benchmarking, adherence to Bureau of Energy Efficiency (BEE) guidelines	
	16	Conducting the energy audit Step-by-Step Audit Procedure: Planning and pre-audit data collection; On-site inspection and instrumentation; Energy flow analysis and benchmarking; Identifying energy conservation opportunities (ECOs); Use of Computer Simulation Tools: Introduction to energy modeling software (e.g., RET Screen, Energy Plus, e-QUEST); Simulating building/lab/industrial energy systems; Input requirements and interpretation of outputs; Predictive energy savings and scenario comparison Developing the Audit Report: Executive summary, methodology, findings, recommendations, financial analysis; Use of graphs, Sankey diagrams, and tables; Report writing best practices and formatting; Communication of findings to stakeholders	6
V	**OPEN ENDED MODULE: Learning through problem-solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams, etc**		**15**
	1.	Assign topics to help students understand the types, uses, and properties of various energy resources.	
	2.	Encourage students to explore the characteristics, benefits, and limitations of different energy sources.	
	3.	Guide students to compare different energy sources based on cost, efficiency, and environmental impact.	
	4.	Promote student-LED projects on innovative and emerging technologies in sustainable energy.	
	5.	Analyze the environmental, social, and economic impacts of different energy sources.	
	6.	Faculty-Initiated Methods Include activities like field visits, expert talks, or online learning modules as suggested by faculty, related to syllabus modules.	
	7.	Engage students in evaluating the practicality and implications of different energy strategies.	
	8.	Policy and Behaviour Analysis Discuss the role of energy policies, technology, and behaviour in moving toward sustainable energy.	
	9.	**Group Activities and Discussions** Assess participation in group discussions, presentations, and collaborative work.	
	10.	**Creative Solutions**: Encourage students to develop creative, real-world solutions to problems related to conventional energy use	

References

1. G. Boyle, *Renewable Energy: Power for a Sustainable Future*, Oxford University Press, 2019.
2. R. K. Rajput, *Energy Technology: Non-Conventional, Renewable and Conventional*, Laxmi Publications.
3. G. D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers.
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15. S. Srinivasan, *Fuel Cells: From Fundamentals to Applications*, Springer.
16. P. Morris and R. Therivel, *Environmental Impact Assessment: Theory and Practice*, Cambridge University Press, 2020.
17. A. Hasanbeigi, L. Price, E. Lin, and H. Lu, *Energy Auditing and Energy Management Handbook*, Academic Press, 2021.
18. A. Thumann, W. J. Younger, and T. Niehus, *Handbook of Energy Audits*, Fairmont Press, 2022.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze the classification, significance, and scientific principles of non-sustainable and non-renewable energy systems, including fossil fuels and nuclear energy, with respect to their environmental implications and energy challenges.	An	1,2,3
CO-2	Analyze the environmental consequences of conventional energy sources by examining pollution, greenhouse gas emissions,	An	1,2,3

	carbon footprint, and the risks of nuclear energy, including accidents and waste management, to understand the need for sustainable alternatives.		
CO-3	Evaluate various renewable energy sources and emerging green energy technologies based on their principles, applications, efficiency, and environmental impact to promote sustainable energy solutions.	E	1,2,3,4
CO-4	Create a comprehensive energy audit plan by integrating data analysis, simulation tools, and sustainability principles to identify and recommend effective energy conservation strategies in industrial and laboratory settings	C	1,2,3,4
CO-5	Demonstrate the ability to critically evaluate, compare, and propose creative, sustainable energy solutions by engaging in collaborative activities, real-world problem-solving, and experiential learning, while analyzing the environmental, economic, and policy dimensions of energy systems.	C	1,2,3,4,5

An-Analyse, E-Evaluate, C-Create

Name of the Course: CHEMISTRY FOR RENEWABLE AND CLEAN ENERGY- I

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	CO-1	PSO-1,2,3 PO-1,2	An	C	L	
2	CO-2	PSO-1,2,3 PO-1,2	An	C	L	
3	CO-3	PSO-1,2,3,4 PO-1,2	E	P	L	
4	CO-4	PSO-1,2,3,4 PO-1,2,7	C	P	L	
5	CO-5	PSO-1,2,3,4,5 PO-1,2	E, C	F, C, P, M	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	2	3	-	-	3	3	-	-	-	-	-	-
CO 2	3	2	3	-	-	3	3	-	-	-	-	-	-
CO 3	3	2	3	2	-	3	3	-	-	-	-	-	-
CO 4	2	3	2	2	-	2	3	-	-	-	-	2	
CO 5	2	3	2	3	2	3	3	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓	✓	✓
CO 5		✓	✓	

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSECHE202**				
Course Title	**ANALYTICAL CHEMISTRY -I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	1. General Chemistry 2. Equilibrium Principles				
Course Summary	This course provides students with the knowledge and skills necessary to understand the principles and practices of analytical chemistry, including the scope, function, and analytical perspective of the field. Students will learn about various analytical techniques, methods for sample preparation and analysis.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		ANALYTICAL CHEMISTRY -I	
I	**INTRODUCTION TO ANALYTICAL CHEMISTRY**		**9**
	1	Scope, function, The Analytical Perspective, Analytical Problems and their solutions, Trends in Analytical Methods and Procedures, Introduction to the terms used in analytical chemistry	3
	2	Qualitative and Quantitative Analysis, Sampling	2
	3	The analytical process: Steps in the analytical process	1
	4	Validation of a method, Use of literature, Analyze Versus Determine	3
II	**BASIC TOOLS OF ANALYTICAL CHEMISTRY**		**9**
	5	The Laboratory Notebook, Laboratory Basic Equipments & Measurements: Volumetric Glassware (Volumetric flasks, Pipets, Syringe pipets, Burets & Use of volumetric Glassware,) The Analytical Balance	2
	6	Units for Expressing Concentration**:** Molarity and Formality, Normality, Molality, Weight, Volume, and Weight-to-Volume Ratios, Converting Between Concentration Units, p-Functions	3
	7	Stoichiometric calculations, Selection of glassware, Preparation of	2

		standard acid & base solutions	
	8	Other apparatus: Desiccators, furnaces & ovens, hoods, wash bottles, Centrifuges & filters, Filter papers	2
III	**LANGUAGE OF ANALYTICAL CHEMISTRY**		**9**
	9	Analysis, Determination, Measurement, Techniques, Methods, Procedures and Protocols, Classifying Analytical Techniques, Use of Literature	2
	10	Selecting an Analytical Method: Accuracy, Precision, Sensitivity, Selectivity, Robustness and Ruggedness, Scale of Operation, Equipment, Time, and Cost, Making the Final Choice	2
	11	Developing the Procedure & Standardizing Analytical Methods: Compensating for Interferences, Calibration and Standardization, Sampling, Validation, Analytical signals, Calibrating the signals, and Sensitivity determination.	2
	12	Being Safe in the Laboratory, Safety culture and Your role in it, Medical Emergencies, Fire, Proper Conduct/Behaviour in lab Personal Protective Equipment: Hair & Apparel for Laboratory, Eye protection, Gloves, Laboratory Protocols: Safe Handling of Chemicals & Equipment, Proper House Keeping, Proper Hygiene, Disposal of Chemicals, Electrical Safety, Fire Safety. Chemical Hazard symbols	3
IV	**CHEMICAL EQUILIBRIUM AND SEMIMICRO QUALITATIVE INORGANIC ANALYSIS**		**18**
	13	Reversible Reactions and Chemical Equilibria, Thermodynamics and Equilibrium Chemistry, Le-Chatelier's Principle, the law of mass action, Factors affecting chemical reactions in solutions	4
	14	Solubility product, Common Ion Effect, Fractional precipitation, Effect of acids, temperature and solvent on the solubility of a precipitate	4
	15	Introduction to semimicro qualitative inorganic analysis, The study of reactions of cations (**Pb^{2+}**, Al^{3+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^+) and anions (CO_3^{2-}, CN^-, Cl^-, Br^-, I^-, F^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, CH_3COO^-, $(COO)_2^{2-}$) on the semi-micro scale	3
	16	Preliminary tests, systematic analysis and Confirmatory tests for anions on the semi micro scale, Modifications of separation procedures in the presence of interfering anions	3
	17	Preparation of solution for cation testing, separation and identification of cations into groups (I, II A, II B, III A, III B, IV & V) on the semi micro scale (Intergroup Separation)	4
V	**OPEN ENDED MODULE: Learning through problem-solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc.**		**15**
	18	Select an analytical method used in a specific industry (e.g., pharmaceuticals, environmental monitoring). Discuss the process of validation and standardization for this method, including the use of literature, compensating for interferences, and calibration techniques.	
	19	Identify, categorize, and describe the uses of apparatus and equipment commonly found in an analytical chemistry laboratory. Provide detailed	

		explanations of the principles behind the operation of each instrument, as well as their applications in qualitative and quantitative analysis.	
	20	Perform stoichiometric calculations and demonstrate the selection and proper use of volumetric glassware, including volumetric flasks, pipettes, syringe pipettes, and burettes. Practice the preparation of standard acid and base solutions and conduct titrations to determine concentration.	
	21	Discuss the importance of proper instrument maintenance, calibration, and troubleshooting to ensure accurate and reproducible measurements.	
	22	Examine the theory and procedures involved in semi-micro qualitative inorganic analysis.	
	23	Discuss the systematic approach to testing for anions and cations, including preliminary tests, confirmatory tests, and separation techniques	
	24	Highlight the challenges and considerations in identifying and eliminating interfering groups.	

References

1. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, *Vogel's Textbook of Quantitative Inorganic Analysis*, Longman, Fifth Edition, 1989.
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th edition, 1996.
3. David Harvey, Modern Analytical Chemistry, McGraw-Hill Education, 1999.
4. B. K. Sharma, *Analytical Chemistry,* Krishna Prakashan Media P. Ltd, 2016.
5. F. W. Fifield, David Kealey, *Principles and Practice of Analytical Chemistry*, 5th edition, Wiley-Blackwel, 2000.
6. D. J. Holme and H. Perk, *Analytical Biochemistry*, 3rd edition, Prentice Hall, 1998.
7. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry* –, Wiley, 7th edition, 2013.
8. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis*, Saunders College Publishing, 5th edition, 1998.
9. G. Svehla, *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*, Longman, 5th edition, 1979.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the scope, function, and analytical perspective of analytical chemistry, the steps involved in the analytical process, gain proficiency in validating analytical methods	An	1,3

CO-2	Learn units for expressing concentration, perform conversions between concentration units, and stoichiometric calculations and prepare standard acid and base solutions.	An	1,3
CO-3	Learn to select analytical methods, develop procedures and standardize analytical methods.	E	1,2
CO-4	Learn about the common ion effect and its impact on equilibrium, systematic analysis techniques on a semi-micro scale for cations and anions,	C	1,2
CO-5	Applies the knowledge in basics of analytical chemistry and semimicro qualitative analysis in problem solving	C	1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY 1

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO-1,3 PO-1,2	An	F, C	L	
2	CO-2	PSO-1,3 PO-1,2	An	C, P	L	
3	CO-3	PSO-1,2 PO-1,2	E	C, P	L	
4	CO-4	PSO-1,2 PO-1,2	C	C, P	L	
5	CO-5	PSO-1,2,3,5 PO-1,2	C	M	T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	3	-	-	-	1	2	-	-	-	-
CO 2	3	-	2	-	-	-	2	2	-	-	-	-

CO 3	2	2	-	-	-	-	3	2	-	-	-	-
CO 4	2	2	-	-	-	-	2	2	-	-	-	-
CO 5	3	2	2	-	3	-	3	2	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	√			√
CO 2	√			√
CO 3	√	√		√
CO 4	√			√
CO 5		√	√	

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSECHE203**				
Course Title	**INDUSTRIAL CHEMISTRY-I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	1. Fundamental concepts of chemistry. 2. Terminology associated with Industrial chemistry				
Course Summary	This course aims to equip students with a comprehensive understanding of various aspects of the chemical industry, including manufacturing processes, industrial applications, safety measures, and the principles of green chemistry, preparing them for careers in the chemical industry with a focus on sustainability and safety.				

Detailed Syllabus:

Module	Unit	Content INDUSTRIAL CHEMISTRY I	Hrs 60
I	**INTRODUCTION TO INDUSTRIAL CHEMISTRY**		**9**
	1	Overview of Chemical Industry- Chemical sectors operating in India (Major sectors)	2
	2	Unit process, unit operations, flow diagrams, energy balance and material balance (basic concepts only)	3
	3	Chemical Industries in Kerala: Location, Raw materials, Chemistry involved in preparation, and uses- TiO_2, Cement, Urea, Ammonium Phosphate and superphosphate of lime.	4
II	**INORGANIC CHEMICALS AND INDUSTRIAL GASES**		**9**
	4	Historical Importance and industrial relevance of Haber's Process for the manufacture of NH_3.	2
	5	Manufacture, Properties and uses of 1) Sulfuric acid, 2) Nitric acid	2
	6	Manufacture, properties and uses of Industrial Gases: 1) Nitrogen 2) Oxygen 3) Carbon dioxide.	3
	7	Manufacture, properties and uses of Lime stone derivative: Lime, Sodium carbonate	2
III	**INDUSTRIAL ASPECTS OF ORGANIC CHEMISTRY**		**9**
	8	Primary raw materials for organic compounds- Petroleum and	2

		natural gas, Petroleum -origin of petroleum – mining of petroleum'-refining processes, Fractionation of crude oil	
	9	Cracking: Thermal and catalytic Processes Reforming: Thermal and catalytic reforming Hydroforming: Conversion of hydrocarbons	3
	10	Coal Chemistry -Types, structure, and properties of coal	2
	11	Coking and gasification processes, distillation of coal- chemicals derived from them.	2
IV	**INDUSTRIAL HAZARDS, SAFETY MEASURES AND GREEN CHEMISTRY**		**18**
	12	Industrial hazards: Definition, Safety signs and colours used in industries	2
	13	Types of hazards: Mechanical hazard, Chemical hazard (Types) Fire Hazard, Dust hazard, Electrical hazard - Causes and preventive measures	4
	14	Introduction to Green Chemistry, Pollution prevention act of 1990, emergence of green chemistry, need for Green Chemistry	2
	15	Twelve principles of green chemistry	1
	16	Atom economy, safer solvents and auxiliaries, ionic liquids-super critical fluids CO2 and H2O, advantages of SCF	4
	17	Catalysis and green chemistry- bio catalysis	2
	18	Alternative sources of energy: Use of microwaves and ultrasonic energy, Renewable resources – biomass, solar energy, hydropower, geothermal energy and tidal energy	3
V	**OPEN ENDED MODULE:** Learning through problem solving, seminars, field trips, open discussions, assignment discussions, quizzes, open book exam etc.		**15**
	1. Properties and applications of industrial gases and inorganic chemicals. 2. Specific unit processes and unit operations used in chemical industries, highlighting their principles, applications, and advancements. 3. Development of strategies to mitigate environmental impact and promote sustainability in chemical manufacturing. 4. Identification and resolution of safety hazards in chemical plants and laboratories. 5. Implementation of green chemistry principles to reduce the use of hazardous substances and energy consumption. 6. Role of renewable energy sources in powering chemical manufacturing processes. 7. Advancements in catalysis and its applications in green chemistry. 8. Innovative techniques for biomass conversion and utilization in the chemical industry. 9. Role of renewable energy sources in powering chemical manufacturing processes. 10. Chemistry and technology of petroleum refining and coal chemistry.		

References

1. Riegel's handbook of Industrial Chemistry, J.A.Kent, CBS Publishers, New Delhi
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4. Survey of Industrial Chemistry,Third Edition,Philip J. Chenier Publications, New Delhi
5. Engineering Chemistry, B.K.Sharma, Goel Publishing House, Meerut
6. S.K.Agarwala and Keemitilal Advanced Inorganic Chemistry
7. Puri, Sharma and Kalia. Principles of Inorganic Chemistry
8. P.L. Soni, Text book of Inorganic Chemistry
9. Industrial Chemistry, O. P. Vermani, A. K. Narula, Galgotia Publications Pvt. Ltd., New Delhi.
10. Industrial Safety Management, 3rd Edition, Deshmukh. L.M., Tata McGraw Hill, New Delhi, 2008
11. Chemical Hazards and Safety, 2nd Edition, Shrikant Dawande, Khanna Publishers, 2012
12. Industries in Kerala, K.R.Rajan.
13. Green Chemistry; Theory and Practice, Anastas. P.T, Warner, J.C.,Oxford University Press, Oxford, U.K, 1998.
14. Green Chemistry Environment Friendly Alternatives, Rashmi Sanghi and M.M Srivasthava, Narosa Publishing House, 2006

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze raw materials, processes, and industrial sectors in India, focusing on Kerala's chemical industries.	An	1,3,5
CO-2	Understand the production, properties and uses, of industrial gases and inorganic chemicals.	An	1,2
CO-3	Explain petroleum and coal processing methods and identify resulting chemical products.	E	1,2
CO-4	Implement safety measures to manage industrial hazards effectively and evaluate industrial processes using green chemistry principles to propose sustainable and environmentally friendly alternatives.	C	1,3,5
CO-5	Critically analyze and apply principles of industrial chemistry to enhance efficiency, safety, and sustainability in chemical manufacturing.	C	1,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: INDUSTRIAL CHEMISTRY-I

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO - 1,3,5 PO – 1, 2	An	C	L	
2	CO-2	PSO - 1,2 PO – 1, 2	An	C	L	
3	CO-3	PSO - 1,2 PO – 1, 2	E	C	L	
4	CO-4	PSO - 1,3,5 PO – 1, 2	C	P,C	L	
5	CO-5	PSO - 1,3,5 PO – 1	C	P,C	T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1	3	-	3	-	2	3	3	-	-	-	-	-	-
CO-2	3	2	-	-	-	3	3	-	-	-	-	-	-
CO-3	3	3	-	-	-	3	3	-	-	-	-	-	-
CO-4	2	-	3	-	2	3	3	-	-	-	-	-	-
CO-5	3	-	2	-	2	2	-	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓		✓
CO-2	✓			✓
CO-3	✓			✓
CO-4	✓	✓		✓
CO-5		✓	✓	

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSECHE204**				
Course Title	**POLYMER CHEMISTRY I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Higher secondary level chemistry				
Course Summary	The course delas with polymer chemistry, students delve into the historical development, classification, methods of polymerization, and diverse applications of polymers, including plastics, engineering plastics, elastomers, and fibers. Through problem-solving exercises, seminars, open discussions, and assessments, students gain a deep understanding of polymer synthesis, structure-property relationships, and real-life applications,				

Detailed Syllabus:

Module	Unit	Content	Hrs
		POLYMER CHEMISTRY I	**60**
I	**BASIC PRINCIPLES OF POLYMER CHEMISTRY**		**12**
	1	Historical development of polymer chemistry. Monomers, polymers, repeating units, functionality.	2
	2	Nomenclature of polymers. Importance and applications of polymers – acrylic, vinyl, cellulose, fluorinated, poly ethylene, & SAN copolymer.	4
	3	Classification of polymers. Ladder and spiral polymers. Cis- trans configuration. DL isomers and tacticity.	3
	4	Inorganic polymers- importance, advantages and applications- structure, preparation and properties of silicones and polyphosphazenes. Comparison with organic polymers.	3
II	**METHODS OF POLYMERIZATION**		**18**
	5	Free radical addition polymerization - Chain growth polymerization. Mechanism of chain growth polymerization. Initiation, propagation and termination. Types of free radical initiators (peroxo, azo and redox initiators). Initiator efficiency. Inhibitors and retarders – functions and examples. Chain transfer reactions.	4

	6	Ionic polymerization – anionic and cationic catalysts, Solvent effects in ionic polymerizations. Mechanism of anionic and cationic polymerizations. Counter ions. Termination modes. Living polymers.	4
	7	Coordination polymerization: stereo regularity, Ziegler-Natta catalysts. Metallocene catalysts. Bimetallic and monometallic mechanisms.	3
	8	Condensation or step growth polymerization-Average functionality, basic characteristics, extent of reaction, degree of polymerization	3
	9	Copolymerization: random, alternate, block and graft. Copolymerization involving two monomers (free radical mechanism). Polymerisation techniques (bulk, solution, suspension and emulsion). Melt, solution and interfacial condensation.	4
III	**PLASTICS AND ENGINEERING PLASTICS**		**9**
	10	Preparation, structure and properties of polyolefins (LDPE, HDPE, LLDPE and PP); vinyl polymers (PVC, Polyvinyl acetals and PMMA);	3
	11	Teflon and polyurethanes; Phenol formaldehyde and urea formaldehyde resins; nylons and polyesters (Terylene and Dacron).	2
	12	Engineering plastics, ABS, polyamides, polycarbonates, PPO, PPS, polysulphones, polyimides, polyesters, flouropolymers, ionomers, and liquid crystalline polymers.	4
IV	**ELASTOMERS AND FIBRES**		**9**
	13	Natural rubber, composition, preservation & coagulation of latex, Structure, properties and preparation of synthetic rubbers (PB, SBR, NBR, polychloroprene, polyisobutylene, IIR, EPDM, buna-N, thiacol). Reclaimed rubbers.	5
	14	Thermoplastic elastomers- advantages, polyurethanes.	2
	15	Fibres: natural (structure and properties); synthetic (structure and properties of nylon, polyester and acrylics)	2
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions on real life applications, assignment discussions, Quizzes, Open book exams, etc on the above four modules.**		**12**

References:

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4. K.J. Saunders, *Organic Polymer Chemistry*, 2nd Edn., Chapman and Hall, London, 1988.
5. Gowri Sankar Misra, *Introductory Polymer Chemistry*, New Age International, New Delhi.
6. P Ghosh, *Polymer Science & Technology*, Tata McGraw Hill Education, 1991.
7. Jeol R. Fried, *Polymer Science & Technology*, Prentice Hall of India (P) Ltd. New Delhi, 1999.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Differentiate between Natural and synthetic polymers	An	PSO-1,2,3
CO-2	Understand polymerization process of monomeric units	An	PSO-1,2,3
CO-3	Critically analyse the advantages and disadvantages of polymers	E	PSO-1,2,3,4
CO-4	Analyse different Applications of Polymers	C	PSO-1,2,3
CO-5	Enhance problem-solving and critical thinking skills, by applying the knowledge of polymer chemistry to address practical challenges	C	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: POLYMER CHEMISTRY I

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	CO-1	PO-1,2,6 PSO-1,2,3	An	F, C	L	
2	CO-2	PO-1,2,6 PSO-1,2,3	An	F, C	L	
3	CO-3	PO-1,2,6 PSO-1,2,3,4	E	C	L	
4	CO-4	PO-1,2,6 PSO-1,2,3	C	P	L	
5	CO-5	PO-1,2,3,6 PSO-1,2,3,4,5	C	P	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	2	2	-	-	2	1	-	-	-	1	-	-
CO 2	2	3	2	-	-	1	1	-	-	-	2	-	-
CO 3	2	2	3	2	-	2	1	-	-	-	2	-	-
CO 4	2	1	2	-	-	2	2	-	-	-	2	-	-
CO 5	1	2	2	1	2	3	2	-	-	-	3	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓	✓	

University of Kerala

Discipline	**CHEMISTRY**				
Course Code	**UK3DSECHE205**				
Course Title	**FORENSIC CHEMISTRY I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Higher secondary level science knowledge				
Course Summary	The course covers topics including Criminology, Domains in Forensic Science, Forensic Laboratories at National and International levels and Forensic Institutions- their Role, Functions, Services, and Functionalities, Role of chemistry in forensic science.				

Detailed Syllabus:

Module	Unit	Content FORENSIC CHEMISTRY I	Hrs 60
I	**INTRODUCTION TO FORENSIC SCIENCE- BASIC PRINCIPLES**		**9**
	1	Introduction, Definition, Significance and Scope of Forensic Science	1
	2	Principles & domains of Forensic Science: Forensic chemistry, Forensic Physics, Forensic biology & Forensic medicine	2
	3	Introduction to Forensic Photography, Ballistics, Fingerprint	1
	4	Introduction to Forensic Psychology, Forensic Anthropology, a n d	1
	5	Computer Forensics / Cyber Forensics: Definition, scope, and importance, Types of cybercrime: hacking, phishing, identity theft, cyberstalking	2
	6	Forensic toxicology: Definition, Classification of poisons: inorganic, organic, synthetic, and natural, Signs and symptoms of poisoning (cyanide, arsenic, alcohol, pesticides), Alcohol detection in blood and breath.	2
II	**CRIMINOLOGY**		**9**
	7	History and Development of Forensic chemistry in India: Pre &Post-Independence Developments	2

	8	Crime: Definition of crime, Characteristics & classification of crimes: White collar crime, professional crime, organized crime.	2
	9	Criminal: Definition of criminal, classification of Criminals based on nature of crime, motive, mental condition & sociological condition (elementary idea only)	3
	10	Criminology: Definition of criminology, classification of criminology based on area of study and application	2
III	**FORENSIC LABORATORIES AND FORENSIC INSTITUTIONS-ROLE, FUNCTIONS**		**9**
	11	Forensic laboratories in India (Centre and Kerala), services and functions of forensic science laboratories.	1
	12	Various institutions and their functioning- NFSU, NCRB, CDTS, CCMB, CDFT, NTRO	2
	13	Qualifications, Duties& Functions of Forensic Scientist	2
	14	Definition of ethics & Ethical issues in Forensic Science	2
	15	Forensic science in national international perspectives, and concept of INTERPOL and FBI.	2
IV	**ROLE OF CHEMISTRY IN FORENSIC SCIENCE**		**18**
	16	Introduction to forensic chemistry, advantages and disadvantages	3
	17	Role of chemistry in crime detection: Identification and Analysis of Substances, Detection of Trace Evidence, Chemical Analysis of Biological Samples, Chemical Reagents for Crime Scene Processing	5
	18	Basics: Concept of accuracy, precision and error	2
	19	Concentration terms: Molarity, Molality, normality, parts per million and interconversions	2
	20	pH of a solution, Theory of Acid -Base titrations, theory of acid base indicators	3
	21	Buffers: buffer action, buffers in biological and forensic system	3
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc**		**15**
	1. Assignments on role of chemistry in crime investigation 2. Visit to forensic Laboratories 3. Debates on present crime issues 4. Presentation on different forensic science laboratories		

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2. Brent E. Turvey, *Criminal Profiling: An Introduction to a Behavioral Evidence Analysis*, Academic Press
3. Sharma, B.R; *Forensic Science in Criminal Investigation & Trials*, Universal Publishing Co., New Delhi, 2003
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Twenty First Century, Select Publisher, New Delhi, 2001.
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6. Prof. N.V. Paranjape Criminology &Penology (including Victimology) Central Law Publications
7. James, S.H and Nordby, J.J; *Forensic Science- An Introduction to Scientific and Investigative Techniques*, CRC Press, USA, 2003.
8. Puri, Sharma & Kalia, *Principles of Inorganic chemistry*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
1	Demonstrate the basic principles of forensic science, principles and various domains.	An	5
2	Illustrate the basics of crime and types of crime, Criminology, Criminology in India.	An	3
3	Recognizes the importance and functions of forensic laboratories and Forensic Institutions.	E	3,5
4	Recognize the role of chemistry and its applications in Forensic Science	C	3
5	Demonstrate the role of forensic Science and chemistry in crime investigation	C	5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E- Evaluate, C-Create

Name of the Course: FORENSIC CHEMISTRY I

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO-1,3,5 PO-1,2,3	An	C	L	
2	CO-2	PSO-1,3,5 PO-1,2,3	An	F, C	L	
3	CO-3	PSO-1,3,5 PO-1,2,3	E	F, C, P	L	
4	CO-4	PSO-1,3,5 PO-1,2,3,8	C	F, C, P	L/T	
5	CO-5	PSO-1,3,5	C	F, C, P, M	T	

		PO-1,2,3,4				

F-Factual, C- Conceptual, P-Procedural, M- Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PS O5**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	3	-	2	-	2	2	2	2	-	-	-	-	-
CO 2	2	-	2	-	3	2	3	1	-	-	-	-	-
CO 3	1	-	2	-	2	1	2	2	-	-	-	-	-
CO 4	2	-	1	-	1	2	1	3	-	-	-	-	3
CO 5	2	-	2	-	2	3	2	1	3	-	-	-	

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓	✓	

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSECHE206**				
Course Title	**CHEMISTRY OF NANOMATERIALS -I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours			4
Pre-requisites	Higher secondary Chemistry				
Course Summary	This course covers the fundamental principles of materials science and engineering, including atomic structure, crystallography, mechanical properties, electrical properties, thermal properties, and magnetic properties. It also explores the synthesis, processing techniques of materials and it's vide applications in various fields**.**				

Detailed Syllabus:

Module	Unit	Course Description CHEMISTRY OF NANOMATERIALS -I	Hrs 60
I	**INTRODUCTION TO MATERIALS SCIENCE**		**9**
	1	Definition and scope of materials science, Classification of Materials- Metals and alloys, Polymers, Ceramics, and Composites	3
	2	Metals and Alloys- basic features and examples Polymer- basic features and examples Ceramics- basic features and examples Composites- types (elementary idea only), main features, and examples	4
	3	Basic application of materials in technology and industry- electronics, automobiles, medicine, and engineering	2
II	**MOLECULAR STRUCTURE OF MATERIALS**		**9**
	4	Bonding forces and energies- Primary interatomic bonds- ionic, covalent, metallic bonding; secondary bonding, Van der Waals forces- Debye, Keesom and London-dispersion forces, hydrogen bonding- inter and intra molecular hydrogen bonding	4
	5	Structure of crystalline solids- Unit cell, Bravais lattices, crystal systems, crystallographic point groups, Weiss and Miller indices. Closed packed crystal structures- BCC, FCC, HCP	3
	6	Defects in crystals: Stoichiometric and non-stoichiometric point defects.	2
III	**PHYSICAL PROPERTIES OF MATERIALS**		**9**

	7	Mechanical properties of metals and polymers: Stress-strain behaviour, tension and compression properties.	2
	8	Thermal properties of polymers and ceramics: Glass transition temperature, thermal stability, and thermal conductivity	2
	9	Electrical properties of metals and alloys: Conductivity and resistivity	2
	10	Magnetic properties of metals and alloys: Saturation magnetisation, coercivity, retentivity, hysteresis loop. Types of magnetic behaviour: Diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferrimagnetism	3
IV	**SYNTHESIS, PROCESSING, AND APPLICATIONS OF MATERIALS**		**18**
	11	Solid-state methods: Powder preparation methods (milling, comminution)	2
	12	Gas-Phase methods: Chemical vapor deposition (CVD) and Physical vapour deposition (PVD)	3
	13	Liquid phase methods: Sol-gel methods, solvothermal, and hydrothermal	2
	14	Emerging Techniques: Additive manufacturing (3D-printing) electrospinning, microwave processing, spark plasma sintering, and nanotechnology (basic idea only)	2
	15	Materials for Energy storage applications Batteries- lithium-ion, sodium-ion Supercapacitors- Activated carbon, MnO_2, Co_3O_4 Conductive polymers: Polyaniline, Polypyrrole	3
	16	Materials for medical applications Metals and alloys: Titanium (Ti) -hip, knee, and dental implants; Titanium and stainless steel -bone screws, plates, stents, braces Cobalt-chrome alloys - Artificial heart valves, joint prostheses Nickel-titanium alloy- stents (elementary idea) Polymers: Polylactic acid (PLA), polyglycolic acid (PGA), polyethylene glycol (PEG) -biodegradable sutures, drug delivery systems Polyethylene terephthalate (PET), polytetrafluoroethylene (PTFE)- Vascular grafts Polyurethane- catheters, pacemaker leads, wound dressings Ceramics: Hydroxyapatite (HA) - bone grafts, coating for metal implants	3
	17	Materials for Environmental remediation applications Materials for Pollution Control- Photocatalytic materials-TiO_2, ZnO Adsorbent materials- Activated carbon, clay, zeolites, fly ash Metal-organic frameworks (MOFs) for gas capture Materials for water treatment- Activated carbon and zeolites: Removal of dyes, pesticides, heavy metals Bio-based adsorbents: chitosan, sawdust, cellulose, alginate	3
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc.**		**15**
		1. Identify and present a real-world application in electronics, medicine, or automotive industry for any one category of metals, polymers and ceramics	

		2. Analyse the stress-strain curve of two materials (e.g., a metal vs. a polymer). 3. Compare and classify physical properties of materials 4. Emerging techniques in materials synthesis (Microwave-Assisted Synthesis, Spark Plasma Sintering (SPS) etc. 5. Investigate the advancements and current challenges in biomedical materials 6. Analyse any nanomaterial-based wastewater treatment technique (e.g., Arsenic removal using iron oxide nanomaterial; dye removal from textile effluents in water treatment using zinc oxide (ZnO) and titanium dioxide (TiO_2) etc. 7. Explore sustainable and eco-friendly materials used in water filtration	

References

1. W.D Callister. Jr, *Materials Science and Engineering*, Wiley India Pvt. Ltd, 2007
2. Raghavan V, *Materials Science and Engineering*, 4th Edition, Prentice Hall of India, 1998
3. Joel I. Gersten and Frederick W. Smit, "*The Physics and Chemistry of Materials*", Wiley, 2007
4. Fahlman, B.D., *Materials Chemistry*, Springer, 2007
5. James F. Shackelford, *Introduction to Materials Science for Engineers*, 8th Edition, 2020
6. William F. Smith and Javad Hashemi, *Foundations of Materials Science and Engineering*; 6th Edition, McGraw-Hill, 2022
7. Huan Pang, Xiaoyu Cao, Limin Zhu, Mingbo Zheng, *Synthesis of Functional Nanomaterials for Electrochemical Energy Storage*, Springer, 2020.
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9. Ajay Kumar Mishra, *Nanomaterials for Water Remediation: Inorganic Oxide Materials, Vol 2*, Smithers-Rapra Publisher, UK, 2016
10. Shivani Bhardwaj Mishra and Ajay Kumar Mishra, *Bio- and Nanosorbents from Natural Resources*, Springer, 2018

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Define the fundamental concepts and scope of materials science, classify materials, and explain their distinct characteristics	An	1,3
CO-2	Understand and explain the nature of interatomic bonding, including primary and secondary bonding forces, crystal structures, and defects in materials	An	1,2
CO-3	Analyse and interpret the mechanical, thermal, electrical, and	E	1,2,3

	magnetic properties of materials		
CO-4	Understand and compare various material synthesis including solid-state, gas-phase, and liquid-phase methods as well as emerging techniques, and apply this knowledge to solve real-world problems related to energy storage, environmental remediation, and biomedical applications.	C	1,3,5
CO-5	Evaluate and apply material properties, synthesis techniques, and innovations for advanced applications in electronics, medicine, automotive, water treatment, and biomedical engineering.	C	1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CHEMISTRY OF NANOMATERIALS -I

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO-1,3 PO-1,2	An	F, C	L	
2	CO-2	PSO-1,2 PO-1,2	An	C	L	
3	CO-3	PSO-1,2,3 PO-1,2	E	C	L	
4	CO-4	PSO-1,2,5 PO-1,2	C	F, C	L	
5	CO-5	PSO-1,2,3 PO-1,2	C	M	T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	2	-	3	-	-	2	1	-	-	-	-	-	-

CO 2	3	3	-	-	-	3	2	-	-	-	-	-	-
CO 3	2	1	3	-	-	3	2	-	-	-	-	-	-
CO 4	3	2	-	-	3	2	2	-	-	-	-	-	-
CO 5	3	3	2	-	-	3	3	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓	✓	✓
CO 5		✓	✓	

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3DSECHE207**				
Course Title	**MEDICINAL AND PHARMACEUTICAL CHEMISTRY I**				
Type of Course	**DSE**				
Semester	3				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pte-requisites	Basic knowledge on organic chemistry				
Course Summary	Introduction to the drug discovery process, Historical perspectives and milestones, Importance of drug discovery in healthcare. Opportunities for innovation in this field. This course outline provides a comprehensive overview of the stages of drug discovery, from lead discovery to regulatory considerations, while also covering essential concepts such as pharmacokinetics and familiarize the pharmacological terms involved.				

Detailed Syllabus:

Module	Unit	Content	Hrs 60
I	**TERMINOLOGIES IN DRUG DISCOVERY AND DEVELOPMENT**		**9**
	1	Introduction to Medicinal and Pharmaceutical chemistry; Important aspects of pharmaceutical chemistry, Role of Chemistry in Pharmacy.	3
	2	Terminologies in Pharmaceutical Chemistry-Pharmacy, Pharmacology, Molecular pharmacology, Pharmacodynamics, Pharmacophore, Pharmacodynamic agents, Antimetabolite, Pharmacokinetics, Bacteria, Virus, Fungi and Mutation	3
	3	Definition of Monograph - types of Monographs (Pharmacopoeial, Regulatory, Scientific, Manufacturers and Analytical Monograph), Organization of Pharmacopoeial Monograph and its significance. Features of Indian Pharmacopoeia.	3
II	**DRUG DESIGN AND DEVELOPMENT**		**18**
	4	Definition of Drugs-Classification based on -Chemical structure and Therapeutic action (only basic knowledge), Introduction to stages of drug discovery (only the steps involved), different targets, target-identification/validation	5
	5	Definition of Lead-Lead identification, Lead optimization, Search for bioactive lead compounds from natural source (Cocaine, Quinine)	3

	6	Serendipity-Accidental Lead Discovery- Penicillin, Sildenafil and Insulin	2
	7	Definition Primary and secondary metabolites - in plants and animals(examples), Metabolism of Drug-Inactivation, Active metabolite from active drug, Activation of inactive drug. Examination of metabolites (eg: paracetamol)	3
	8	Side effect of drug-Predictable and Unpredictable. Exploitation of side effect of drug (eg: Minoxidil)	1
	9	Need of molecular modification of Lead Compound-Modification of progestron as an example (structure of progestron and orally active modified compound)	2
	10	Drug potency - familiarize the terms ED_{50}, LD_{50}, IC_{50}, TI (Therapeutic index) Bioassay: *in vitro* test and *in vivo* test and its importance.	2
III	**INTRODUCTION TO PHARMACOGNOSY AND EVALUATION OF CRUDE DRUG**		**9**
	11	Definition, history, present status and scope of Pharmacognosy	2
	12	Elementary idea on classification of drugs: Alphabetical -Taxonomical - Pharmacological - Chemical - Chemo-taxonomical.	3
	13	Quality control of crude drugs: Different methods of adulteration of crude drugs - Evaluation of crude drug-Organoleptic, Microscopic, Physical, Chemical and Biological.	4
IV	**TRADITIONAL AND MODERN METHODS OF DRUG DEVELOPMENT**		**9**
	14	Drug-Discovery and development in the -Past, Present; Comparison of traditional and modern methods of development of drugs.	2
	15	Drug design by- Method of Variation, Disjunction and Conjunction. Introduction to computer aided drug design (CADD)-Structure Based and Ligand based drug discovery (elementary idea only). Scope of AI in drug discovery (example-alpha fold for protein structure prediction)	4
	16	Medicinal Plants of Ayurvedic importance – common name- traditional uses - Major phytochemical constituents-*Ocimum tenuiflorum* (Thulsi), *Azadirachta indica* (Neem), *Vinca rosea* (Madagascar Periwinkle), *Indigofera tinctoria* (Nilamari), *Adhatoda vasica* (Adalodakam), *Curcuma longa* (Turmeric), *Cymbopogon citratus* (lemon grass), *Zingiber officinale* (Ginger), *Aloe vera*, *Plectranthus amboinicus* (Panikkurka), *Clitoria ternatea* (Shankupushpam).	3
V	**OPEN ENDED MODULE: Learning through Discussion, Assignment, Presentation, Quizzes, Open book exams etc**		**15**
	1	Provide examples of successful target identification and validation processes in drug discovery. Ask students to analyze these cases and discuss the importance of target selection. Presentation on topic Virus to Vaccine: The Journey of COVID-19 Vaccine Development	
	2	Students search the stories behind the accidental discoveries till now and discuss the implications for modern drug discovery	
	3	Assignment to identify the medicinal plants of regional importance and find the major bioactive metabolites and its medicinal values.	
	4	Conduct power point presentation on classification of drugs elucidating	

		examples each based on Alphabetical, Taxonomical, Pharmacological, Chemical and Chemo-taxonomical classification.	
	5	Conduct quiz on regional name and botanical name of various medicinal plants of Ayurvedic importance	
	6	Ask student to Choose **any one or two** real-life examples of drugs or research projects where CADD made a difference.	

References

1. Patrick, G.L. (2013). *Introduction to Medicinal Chemistry* (5th Edition). UK: Oxford University Press.
2. Patrick G, (2002), *Instant Notes Medicinal Chemistry*, Viva Books Private Limited, New Delhi.
3. Chatwal G R, (1991), *Pharmaceutical chemistry, organic (vol-II)*., Himalaya publishing house, Bombay.
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5. K.R. Arumugam and Dr. N. Murugesh, *A Text Book of Pharmacognosy*.
6. K.D Tripathi, *Essentials of Medical pharmacology*, 8th edition.
7. Tara V Shanbhag and Smita Shenoy*, Pharmacology for Medical Graduates*, 4th edition
8. Hakishan, V.K. Kapoor, (2017). *Medicinal and Pharmaceutical Chemistry*, New Delhi: Vallabh Prakashan. Pitampura
9. Jayashree Ghosh, (1999), *A text book of pharmaceutical chemistry*, 2nd ed., S. Chand & company, New Delhi.
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11. *Principles of Medicinal Chemistry: Modern Methods in Drug Design*: John Smith, Emily Johnson: Wiley,2020.
12. *A handbook of common Medicinal Plants in Ayurveda*
13. *Indian Medicinal Plants*: C.P. Khare (available online).

Course Outcome

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand basic principles of medicinal and pharmaceutical chemistry, including essential terminologies and classification of drugs.	An	3,5
CO-2	Apply the importance of functional group and the structure of compounds in various pharmacological activity.	C	1,3
CO-3	Identify and evaluate different types of adulteration in crude drugs and apply standard methods of quality control. Perform basic evaluation of crude drugs using different methods.	An	1,5

CO-4	These topics equip students with a comprehensive understanding of natural drugs, their origins, chemical constituents, and therapeutic applications	E	1,3
CO-5	These tasks provide a comprehensive understanding of various aspects of drug discovery, from target identification to drug classification and traditional medicine. They foster critical thinking, research skills, and an appreciation for the complexities of modern pharmacology.	C	1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: MEDICINAL AND PHARMACEUTICAL CHEMISTRY I

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO-3,5 PO-2,4	An	F	L	-
2	CO-2	PSO-1,3 PO-1	C	C, P	L/T	-
3	CO-3	PSO-1,5 PO-3	An	F, C	L/T	-
4	CO- 4	PSO-1,3 PO-1	E	C, P	L	-
5	CO- 5	PSO-1,2,3 PO-2	C	C, P	L/T	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	-	-	2	-	1	-	1	-	2	-	-	-	-
CO 2	1	-	3	-	-	2	-	-	-	-	-	-	-
CO 3	2	-	-	-	2	-	-	2	-	-	-	-	-
CO 4	3	-	2	-	-	3	-	-	-	-	-	-	-

CO 5	1	2	1	-	-	-	3	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓	✓	✓
CO 5		✓	✓	

University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK3VACCHE200**				
Course Title	**LABORATORY SAFETY**				
Type of Course	**VAC**				
Semester	3				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Basic science knowledge and interest in chemistry				
Course Summary	This course provides comprehensive training on laboratory safety protocols, chemical hazards, proper handling of chemicals and apparatus, safety equipment usage, emergency procedures, and laboratory waste management, with a focus on Indian regulations and challenges. Students will gain essential knowledge and skills to ensure safe and responsible practices in chemical laboratories, emphasizing compliance with legal frameworks and environmental protection.				

Detailed Syllabus:

Module	Unit	Content	Hrs
	LABORATORY SAFETY		**45**
I	**INTRODUCTION TO LAB SAFETY**		**6**
	1	Introduction, Eye Protection-Clothing- Gloves, Laboratory Protocol - Laboratory Visitors - Comportment in the Laboratory	3
	2	Housekeeping-Cleaning Glassware - Inhaling Harmful Chemicals – Distillations – Extraction – Refrigerators - Disposal - General Disposal Guidelines.	3
II	**CHEMICAL HAZARDS**		**9**
	3	Types of Chemical Hazards – Physical, health and environmental. Exposure Limits – TLV, STEL and IDLH, Sources of Information, Material Safety Data Sheets (MSDSs), Understanding an MSDS, CIS understanding HAZCHEM Code, class, - Basic ideas of emergency response guides.	4
	4	Learning Chemistry from an MSDS (eg: Alcohols, Hydrocarbons, CCl4, CHCl3 & THF), Solvents and Their Hazards - Acids and Bases - A Few Examples of Toxic Materials – Chlorine, H2SO4, phenol & carbides -	5

		Organic Peroxides and Peroxide Formers, Handling of radioactive substances, Physical hazards, Environment hazards and symbols	
III	**WORKING WITH CHEMICALS AND APPARATUS**		**6**
	5	Equipment Use - Laboratory Hoods, Precautions for Using Electrical Equipment, Centrifuges, Using Steam, Using High-Pressure Air, Ultraviolet Lamps.	3
	6	Controlling Temperature - Oil and Sand Baths, Cooling Baths and Cold Traps, Dry Ice Cooling Baths and Cold Traps, Cryogenic Liquid Cooling Baths and Cold Traps, Working with Reduced Pressure.	3
IV	**SAFETY EQUIPMENT, EMERGENCY PROCEDURES & LABORATORY WASTE MANAGEMENT**		**15**
	7	General Information, Fires – Types of Fires & Extinguishing Media, Fire Prevention, dealing with a Fire, Personal Injuries Involving Fires & their first aid	3
	8	Chemicals on Skin, Clothing, and Eyes, Other Personal Injury Accidents & first aids, Spill Cleanup	4
	9	Introduction to waste management, Chemical waste disposal, glass disposal, emergency procedures, Response to incidents and accidents	3
	10	Indian regulations on chemical and hazardous waste management, Brief idea on Legal Framework on Chemical and Hazardous Waste in India, Issues and Challenges in Production, Storage and Transport of Chemicals in India, General provision on Storage, Handling & Transportation of chemicals.	5
V	**OPEN ENDED MODULE:**		**9**
	11	Seminar presentations, group discussions, debates, quizzes, case studies etc on the above modules - searching for safety equipments and identify potential hazards in the lab - case studies involving lab accidents or safety violations – Inspections in the lab for safety hazards - Creative and practical designs and innovative ideas for personal protection, hazard warnings, emergency response systems etc. **(Or any other related activities introduced by the teacher)**	

References

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2. *Techniques of Safety Management* (ISBN: 978-18-8-558139-6), Dan Petersen, McGraw-Hill Book Co. Ltd., New York, N.Y. USA.
3. *Hazardous Chemical Data Book* (ISBN:081-551072-1), G. Weiss, Noyes Data Corporation, Park Ridge, New Jersey, N.Y. (USA).
4. *Environmental Health & Safety Management*, Nicholas & Madelyn, Jaico Publishing House, Mumbai.
5. *Hazardous waste management, Volume II, Characterisation and treatment process*, Sukalyan Sen Gupta.

6. *Solid and Hazardous waste management*, 2nd edition, M.N.Rao.
7. *Handbook on chemicals & hazardous waste management & handling in India*, MOEFCC.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Safely and effectively implement laboratory protocols, including the use of personal protective equipment, proper handling of chemicals and glassware, adherence to housekeeping standards, and appropriate disposal methods to ensure a safe and compliant laboratory environment.	An	PSO-2,3,4,5
CO-2	Identify and classify hazardous chemicals based on their toxicity, explosivity, flammability, corrosivity, and environmental impact, accurately interpret Material Safety Data Sheets (MSDS) and chemical labels, and apply safety measures to manage physical and environmental hazards effectively.	An	PSO-2,3,4,5
CO-3	Safely operate and maintain laboratory equipment—including hoods, electrical devices, centrifuges, steam systems, high-pressure air, and ultraviolet lamps—and effectively apply various temperature control techniques.	E	PSO-2,3,4,5
CO-4	Understand and apply principles of fire prevention and emergency response, manage chemical and personal injury incidents safely, execute proper waste disposal methods, and comprehend the regulatory and legal framework governing chemical and hazardous waste management in India, including challenges in chemical production, storage, and transport.	C	PSO-2,3,4,5
CO-5	Develop the ability to identify laboratory hazards, understand safety equipment, and design effective personal protection and emergency response solutions to ensure a safe working environment.	C	PSO-2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: LABORATORY SAFETY

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO-1,2,3,6,8 PSO-2,3,4,5	An	C, P	L	-
2	CO-2	PO-1,2,6,8 PSO-2,3,4,5	An	C, P	L	-
3	CO-3	PO-1,2,3,6,8 PSO-2,3,4,5	E	C, P	L	-
4	CO-4	PO-1,2,3,6,8 PSO-2,3,4,5	C	P, M	L	-
5	CO-5	PO-1,2,3,6,8 PSO-2,3,4,5	C	P, M	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO2
CO 1	-	1	3	3	2	1	2	2	-	-	2	-	2
CO 2	-	1	3	3	2	2	2	1	-	-	2	-	2
CO 3	-	1	3	3	2	1	2	2	-	-	3	-	2
CO 4	-	1	3	3	2	1	2	1	-	-	2	-	2
CO 5	-	1	3	3	2	2	1	1	-	-	3	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments

- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓		✓	✓