FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**PHYSICAL CHEMISTRY – I: STATES OF MATTER**				
Type of Course	**MAJOR/MINOR**				
Semester	**II**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NCERT or equivalent chemistry syllabus of XI and XII, https://onlinecourses.swayam2.ac.in/nce24_sc07/preview				
Course Summary	Atoms and molecules form the matter that is recognisable for us in the real world, as gases, liquids and solids. Why would they exist as they are? And why would they behave as they do? This course is designed to introduce first year UG students, the physical chemistry of matter in different states of its existence through theory and laboratory experiments. The course explains the various types of interactions between atoms and molecules and their important role in physical and chemical characteristics of the different states of matter. The course introduces the theory and experimental methods that are commonly used to study the various states of matter.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the basic nature of real gases and understand interactions at molecular levels	U	C	Assignments/Quiz designed by the instructor
CO2	To recognise the significance of various interactions in condensed matter	U	C	Assignments/Quiz designed by the instructor

CO3	To analyse the physical properties of liquids through theory and practical experiments	An	P	Seminars and exams
CO4	To explain the regular, periodic arrangement of atoms in solids and appreciate the concept of unit cells	An	P	Seminars/ exams
CO 5	To evaluate and understand the importance of the X-ray diffraction technique for characterisation of crystalline solids	Ap	P	Lab/Discussion/Assignments
CO 6	To execute experiments to determine and tune the various colligative properties of dilute solutions	C	P	Lab/Viva voce exams

* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks
I		**GASEOUS STATE**	**15**	**33**
	1	Kinetic theory of gasses: derivation	**1**	
	2	Maxwell-Boltzmann distribution of molecular velocities -– Average velocity, RMS velocity and most probable velocity (derivations not required)	**2**	
	3	Collision theory – Collision diameter- Collision number-Collision frequency - Mean free path – Molecular beams (Mention only)	**2**	
	4	Real gas- Deviation from ideal behavior- Compressibility factor – Virial equation and Virial coefficients- van der Waals equation of state (derivation required)-features of van der Waals equation - Expression of van der Waals equation in virial form and calculation of Boyle temperature - PV isotherms of real gasses – Andrews' experiments - Continuity of states - Isotherm of van der Waals equation	**6**	

	5	Critical phenomena - Critical constants - Relationship between critical constants and van der Waals constants - Experimental determination of critical constants - Supercritical carbon dioxide and its applications.	**4**	
II	**LIQUID STATE**		**8**	**17**
	6	Discussion of different types (with suitable examples) of molecular interactions- dipole-dipole, dipole-induced dipole, induced dipole-induced dipole interactions, Lennard-Jones 6-12 potential.	**2**	
	7	Properties of liquids- Vapour pressure, Refractive index, Surface tension- Interfacial tension and viscosity - Poiseuille's equation – Explanation of these properties on the basis of intermolecular forces.	**3**	
	8	Hydrogen bonding in water and other polar molecules, its relevance in biological systems.	**2**	
	9	Liquids on solid surfaces- Hydrophobic and Hydrophilic, Superhydrophilic and Superhydrophobic surfaces- simple explanation by using the water drop contact angles on surfaces	**1**	
III	**SOLID STATE**		**15**	**33**
	10	Crystalline and amorphous solids- atomic and molecular solids- nucleation and growth of crystals.	**2**	
	11	Crystalline Materials – Periodicity- Types of Close packing and packing fraction.	**1**	
	12	Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended).	**4**	
	13	X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor,	**3**	
	14	Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction.	**3**	
	15	Structural transitions in TiO_2- anatase, rutile and brookite phases	**1**	
	16	Concepts of melting point/boiling point and molecular/atomic/ionic interactions, Examples: CO_2, N_2, H_2O, NH_3, NaCl, TiO_2	**1**	
IV	**SOLUTIONS**		**7**	**15**

	17	Solubility of gases in liquids – Henry's law and its applications	**1**	
	18	Colligative properties - Relative lowering of vapour pressure	**1**	
	19	Colligative properties- Elevation in boiling point and depression in freezing point	**1**	
	20	Colligative properties- Osmotic pressure - Laws of osmotic pressure - Reverse osmosis and its technological relevance	**1**	
	21	Determination of molecular mass using colligative properties	**1**	
	22	Solid Solutions: Substitutional and interstitial solid solutions, Differences between Alloys, Mixtures and Composites. Colloids: Dispersed phase and dispersing medium, Sol, Emulsion, Foam, and Aerosol, Tyndall effect, Nephelometry	**2**	
V		**PHYSICAL CHEMISTRY PRACTICALS**	**30**	
		A minimum of 5 practical experiments out of which ONE EACH from sections 1, 2 and THREE from section 3 must be performed and reported. For plots/graphs, suitable softwares may be used and printed hard copies may be presented. Practical records may be in handwritten or computer-typed printed form. **Section 1** 1. Determination of cryoscopic constant (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 cryoscopic constant (K_f). (Solvent: Naphthalene, biphenyl Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine) **Section 2** 3. Determination of molal transition point depression constant (K_t) of salt hydrate using solute of known molecular mass. (Salt hydrates: $Na_2S_2O_3.5H_2O$, $CH_3COONa.3H_2O$. Solutes: Urea, Glucose) 4. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (K_t). (Salt hydrates: $Na_2S_2O_3.5H_2O$, $CH_3COONa.3H_2O$. Solutes: Urea, Glucose)	**3** **3** **3** **3**	

		Section 3 5. Determination of viscosity of various liquids using Ostwald's viscometer. 6. Study of glycerine-water system and determination of percentage of glycerine using viscometer [plot composition (c) *versus* time of flow x density of the solution (td)]. 7. Determination of the surface tension of a liquid or a dilute solution (NaCl / surfactant) using a stalagmometer (drop number method). 8. Determination of composition of glycerine-water mixture by refractive index method. 9. Determination of refractive indices of KCl solutions of different concentrations and unknown concentration of KCl solution. 10. 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)	**3** **3** **3** **3** **3**	
		References: **Module I o IV** 1. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) 2. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.) 3. Solid State Chemistry and its Applications, 2nd Edition, A R West, (Wiley, 2014) **Module V** 4. Findlay's Practical Physical Chemistry, Ninth Edition, Revised and Edited by B P Levitt, (Longman, London, 1973) 5. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.. 6. R. C. Das, B. Behra, Experiments in Physical Chemistry, Tata McGraw Hill, New Delhi, 1983.		

		Further reading 7. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013. 8. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006. 9. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Edn.,John Wiley and Sons, Canada, 1980. 10. D. P. Shoemaker, C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill Book Company, New York, 1962. 11. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, Cambridge, 2009		

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-	3	2	3	2	2	-	2	-	1
CO 2	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 3	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 4	3	2	-	-	3	3	3	2	1	-	1	-	1
CO 5	3	2	2	1	3	3	3	2	1	-	3	-	1
CO 6	2	-	3	3	3	3	3	2	1	2	3	2	1

Correlation Levels:

Level	Correlation
-	Nil

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

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1		✓		✓
CO 2		✓		✓
CO 3	✓			✓
CO 4	✓			✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**STATES OF MATTER AND NUCLEAR CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Gaseous and Liquid states of matter 2. Basic idea about nucleons 3. Basic knowledge in analytical principles				
Course Summary	1. This course provides the students a thorough knowledge about gaseous and liquid states of matter and the continuity between them. 2. This course aims to introduce the applications of nuclear chemistry 3. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts and the properties of gaseous state and how it relates to thermodynamic systems.	U	F	Instructor-created exams / Quiz /Assignment
CO2	To understand the behaviour of ideal and non-ideal solutions	E	C	Instructor-created exams / Quiz /Assignment
CO3	To analyse the properties of gases and liquids.	An	C	Instructor-created exams / Quiz /Assignment
CO4	To apply the theories of different states of matter and understand their implications.	Ap	F	Instructor-created exams / Quiz /Assignment

CO5	To describe various processes in nuclear chemistry	U	C	Instructor-created exams / Quiz /Assignment
CO6	To analyse cations from a given mixture and enable the students to determine the physical constants.	An	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (75)	Marks
I	**Gaseous State - I**		**10**	**22**
	1	Characteristics of gases	1	
	2	Postulates of kinetic theory of gases	2	
	3	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3	
	4	Collision number – Mean free path – Collision diameter	1	
	5	Viscosity of gases, including their temperature and pressure dependence,	1	
	6	Relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.	2	
II	**Gaseous State - II**		**10**	**22**
	7	Behaviour of real gases - Deviation from ideal behaviour – Compressibility factor	3	
	8	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	9	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	10	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) –	2	

		Relationship between critical constants and van der Waals constants.		
III	**Solutions and Liquid crystals**		**15**	**32**
	11	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	12	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	13	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	14	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapor pressure – Elevation of boiling point,– Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	15	– Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor	2	
	16	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	17	Applications of liquid crystals.	1	
IV	**Nuclear Chemistry**		**10**	**22**
	18	Natural radioactivity – Modes of decay – Group displacement law.	2	
	19	Nuclear forces - n/p ratio - Nuclear stability - Mass Defect - Binding energy	2	
	10	Isotopes, isobars and isotones with examples. Nuclear fission - Atom bomb - Nuclear fusion – Hydrogen bomb	1	
	21	Nuclear reactors	1	
	22	Application of radioactive isotopes – ^{14}C dating, Rock dating, Isotopes as tracers, Radio diagnosis, Radiotherapy. Problems	4	
V	**Practical**		**30**	

	A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher			
	1	a) Inorganic Qualitative Analysis (semi – micro analysis) ● Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH_4^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+} , Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, and Mg^{2+} ● Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures)	25	
	2	b) Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc.]	5	

Reference Books

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn., 2017.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017 G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
4. 1. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn., New Age International (P) Ltd., New Delhi, 1995
5. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
6. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
7. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
8. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2				2		1						
CO 2	2				2		1						
CO 3	2				2		1						
CO 4	2				2		1						
CO 5	2				2		1						
CO 6			2		2		1				1		

Correlation Levels :

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6	✓	✓	✓	

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**SOLUTIONS AND SURFACE CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic idea of solutions 2. Colloids – Definition and classification 3. Fundamentals of surface phenomena 4. Basic knowledge in analytical principles				
Course Summary	1. This course provide the students a thorough knowledge about various properties of liquids 2. This course aims to impart an idea about importance of colloids 3. This course aims to develop the concept of adsorption and separation techniques 4. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts and the properties of liquids	U	F	Instructor-created exams / Quiz /Assignment
CO2	To evaluate the importance of colligative properties.	E	C	Instructor-created exams / Quiz /Assignment
CO3	To differentiate different types of colloids and explain their properties and applications.	U	C	Instructor-created exams / Quiz /Assignment
CO4	To appreciate the importance of surface phenomena in chemistry	U	C	Instructor-created exams / Quiz /Assignment

CO5	To perform the cation analysis on a provided mixture containing two cations.	An	P	Lab work
CO6	To enable the students to determine the physical properties (physical constants).	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Solutions**		**15**	**32**
	1	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	2	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	3	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	4	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapour pressure – Elevation of boiling point,– Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	5	– Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor	2	
	6	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	7	Applications of liquid crystals.	1	
II	**Colloids**		**10**	**22**
	8	True solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples.	2	
	9	Purification of colloids by electrodialysis and ultrafiltration	2	
	10	Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis.	2	
	11	Origin of charge and stability of colloids – Coagulation - Hardy Schulze rule – Protective colloids - Gold number. Emulsions.	2	
	12	Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.	2	
III	**Adsorption and Catalysis**		**10**	**22**
	13	Adsorption, Physical and chemical adsorption, factors affecting adsorption.	2	
	14	Adsorption isotherms: Freundlich and Langmuir isotherms (derivation not required) –	2	
	15	Applications of adsorption.	1	

	16	Catalysis: Homogeneous and heterogenous catalysis – Theories of homogenous and heterogenous catalysis	3	
	17	Enzyme catalysis – Michaelis-Menten equation (derivation not required).	2	
IV	**Separation Techniques**		**10**	**22**
	18	Chromatography- Introduction - Adsorption and partition chromatography - Development of chromatogams: frontal, elution and displacement methods	2	
	19	Qualitative and quantitative aspects of principle and applications of column, thin layer, paper and gas chromatography	2	
	20	Rf value – Relative merits of different techniques	2	
	21	Solvent extraction: Classification, principle and efficiency of the technique.	2	
	22	Extraction of metal ions from aqueous solution,	2	
V	**Practical** A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		**30**	
	1	Inorganic Qualitative Analysis (semi – micro analysis) ● Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH_4^+, Pb^{2+}, $Cu^{2+,}$ Cd^{2+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+} , Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, and Mg^{2+} ● Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures)	25	
	2	Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc]	5	

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.

4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
5. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
6. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
7. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
8. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
10. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
11. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
12. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2				2		1						
CO2	2				2		1						
CO3	2				2		1						
CO4	2				2		1						
CO5			2		2		1				1		
CO6			2		2		1				1		

Correlation Levels :

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓	✓	✓
CO6	✓	✓	✓	

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**FUNDAMENTALS OF PHYSICAL CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamentals of Thermodynamics 2. General idea about state of equilibrium 3. Basic idea about order of reaction 4. Basic knowledge in analytical principles and structure of molecules				
Course Summary	1. This course aims to familiarise the students with the concepts of thermodynamics, kinetics and photochemistry. 2. This course also aims to impart an idea about ionic and phase equilibrium 3. This course also aims to develop proficiency in analytical tools and to draw molecular structures using softwares				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts thermodynamic processes	U	F	Instructor-created exams / Quiz /Assignment
CO2	To evaluate the importance of ionic and phase equilibrium.	E	C	Instructor-created exams / Quiz /Assignment
CO3	To analyse the order of different reactions	An	C	Instructor-created exams / Quiz /Assignment
CO4	To appreciate the importance of photochemistry	U	C	Instructor-created exams /

				Quiz /Assignment
CO5	To create structures of different molecules and calculation of different parameters	C	P	Lab work
CO6	To enable the students to determine the physical properties (physical constants).	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Thermodynamics**	**10**	**22**
	1	Definition of thermodynamic terms – System – Surroundings – Types of systems,	1	
	2	First law of Thermodynamics – Internal energy – Significance of internal energy change –Enthalpy	2	
	3	Second law of Thermodynamics – Entropy and spontaneity – Statement of second law based on entropy.	2	
	4	Entropy change in phase transitions (derivation not required) – Entropy of fusion, vaporization and sublimation.	2	
	5	The concept of Gibbs free energy – Physical significance of free energy –	1	
	6	Conditions for equilibrium and spontaneity based on ΔG values – Effect of temperature on spontaneity of reaction. Third law of Thermodynamics.	2	
II		**Ionic and Phase Equilibria**	**10**	**22**
	7	Introduction to acid base theories – pKa, pKb and pH	1	
	8	Buffer solutions Mechanism of buffer action – Buffer index – Henderson equation – Applications of buffers	2	
	9	Hydrolysis of salts of all types – Degree of hydrolysis – Hydrolysis constant and its relation with Kw	1	
	10	Solubility product and common ion effect.	2	
	11	Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs phase Rule	2	
	12	Phase diagrams of one-component systems – e.g.: water	2	
III		**Chemical Kinetics**	**15**	**32**
	13	The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction.	3	

	14	Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants).	5	
	15	Half-life of a reaction. General methods for determination of order of a reaction.	2	
	16	Concept of activation energy and its calculation from Arrhenius equation (qualitative treatment only)	3	
	17	problems	2	
IV	**Photochemistry**		**10**	**22**
	18	Introduction – Difference between thermal and photochemical processes – Characteristics of electromagnetic radiation - Beer Lambert's law.	3	
	19	Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence.	1	
	20	Quantum yield and its explanation with example – Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence.	3	
	21	Photosensitization, Role of photochemical reactions in biochemical processes	2	
	22	Photostationary states – Chemiluminescence	1	
V	**Practical** A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		**30**	
	1	● Absorption (and transmittance) measurements of a colourless and a coloured light absorbing substance in a solution by using a spectrophotometer either experimentally or by simulation. For simulation use https://mas-iiith.vlabs.ac.in/exp/uv-visible-spectroscopy/simulation/expt1/mas_expt1.html ● Verify Beer Law using a spectrophotometer either experimentally or by simulation. For simulation use https://mas-iiith.vlabs.ac.in/exp/beer-law/simulation/expt4/mas_expt4.html https://mas-iiith.vlabs.ac.in/exp/lambert-law/simulation/expt3/mas_expt3.html https://mas-iiith.vlabs.ac.in/exp/beer-lambert-law/simulation/expt6/mas_expt6.html ● Draw structures of organic molecules using any chemistry structure drawing softwares/websites (any five molecules) Samples: https://molview.org/ https://pubchem.ncbi.nlm.nih.gov//edit3/index.html https://www.chemspider.com/StructureSearch.aspx	25	

		http://www.kingdraw.cn/en/ https://www.rcsb.org/chemical-sketch ● Measure the bond length and bond angle of organic molecules using softwares Samples: https://molview.org/ ● Determination of heat of solution (ΔH) of oxalic acid/benzoic acid from solubility measurement.		
	2	● Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of velocity constant for acid hydrolysis of methyl acetate. Determination of velocity constant for the saponification of ethyl acetate. Preparation of buffers and determination of pH values of fruitjuices using pH meter. Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.	5	

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
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5. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013.
6. K. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education, New Delhi, 2004.
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Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2				2		1						
CO2	2				2		1						
CO3	2				2		1						
CO4	2				2		1						
CO5			2		2		1				1		
CO6			2		2		1				1		

Correlation Levels :

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓	✓	
CO6	✓	✓	✓	

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**CHEMISTRY IN DAILY LIFE**				
Type of Course	**MDC**				
Semester	**II**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Role of chemicals in or life. Basic idea of environmental pollution.				
Course Summary	This course ensures that the students acquire a profound knowledge and understanding on chemicals that are used in daily life.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	*Know the different chemicals that sustain our life*	**U**	**C**	Instructor-created exams / Quiz
CO2	*Understand the role of chemistry in forensic analysis.*	U	C	Instructor-created exams / Seminar
CO3	*Understand the application of chemistry in agriculture and need of green methods*	U	C	Instructor-created exams /Assignment
CO4	*Understand the chemistry of soaps, synthetic detergents and their environmental effects.*	U	C	Instructor-created exams / Seminar
CO5	*Understand the chemistry of cosmetics and the effect on health.*	U	C	Instructor-created exams / Quiz

CO6	*Understand the chemistry of drugs,food additives their action and possible side effects*	U	C	Seminar/Viva

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I	**Chemistry in Biological Systems & Forensic Chemistry**		**12**	**22**
	1	Vitamins and Minerals: Name, source, function and deficiency diseases.	2	
	2	Enzymes - Classifications, characteristics, examples.	1	
	3	Hormones - Sex hormones - example, function. Pheromones.	2	
	4	Brain chemicals and human mood variations	1	
	5	General discussion of poisons with special reference to mode of action of cyanide, organophosphates and snake venom.	2	
	6	Detection of finger print, blood stain, semen, Breath analyzer	2	
	7	Sport doping-Steroids-Anabolic agents, Stimulants, Diuretics	2	
II	**Chemistry and Agriculture**		**6**	**12**
	8	Essential nutrients for plants – NPK value Chemical composition of soil, Soil enrichment	1	
	9	Fertilizers- natural, synthetic, mixed, NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio fertilizers.	2	
	10	Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides	2	
	11	Pesticide pollution and its impact on environment – Endosulfan disaster in Kerala (brief study).	1	
III	**Cleansing agents and cosmetics**		**9**	**18**
	12	Soaps – Hard and soft soaps – Alkali content – TFM – Detergents (classification) – Cleaning action – Advantages and disadvantages of soaps and detergents –	3	
	13	Shampoos: Ingredients and functions – Different kinds of shampoos (Antidandruff, anti-lice, herbal and baby shampoos).	1	
	14	Tooth paste: Composition and health effects. Hair dye: Chemicals used and its harmful effects.	1	
	15	Face and skin powders: Types, ingredients and functions. Cleansing creams: Cold creams, vanishing creams and bleach creams.	2	

	16	Perfumes, antiperspirants, sun screen preparations, nail polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics.	2	
IV	**Pharmaceuticals and Dyes**		**9**	**18**
	17	Drug: Chemical name, generic name and trade names with examples.	1	
	18	Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only).	2	
	19	Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).	2	
	20	Dyes: classification based on constitution, application, examples, uses.	2	
	21	Dyes: Requirements of a dye – Classification based on mode of application to the fabric –	1	
	22	Applications of dyes (general study). Ancient and modern colours – Mention of indigo and alizarin.	1	
V		**Food Chemistry (OPEN ENDED)**	**9**	
	23	Common adulterants Food Additives: Artificial sweeteners – Taste enhancers Artificial ripening of fruits and its side effects. Modern Food Habits:		

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1. M. V. Kulkarni, *Biochemistry*, Pragati Books Pvt. Ltd., 2008.
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4. N. V. Bhagavan, *Medical Biochemistry*, Academic Press, 2002.
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6. Quantitative Analysis of drugs, P.D. Sethi, 3rd edition, CBS Publishers, New Delhi, 1997.
7. Practical Clinical biochemistry methods and interpretations, R. Chawala, J.P. Brothers Medical Publishers (P) Ltd., 1995.
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13. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
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18. H. S. Ramaswamy, M. Marcotte, *Food Processing: Principles and Applications*, CRC Press, 2005.
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20. T. A. M. Sagati, The Chemistry of Food Additives and Preservatives, John Wiley & Sons, 2012.
21. S. N. Mahindru, *Food Additives*, APH Publishing, 2009.
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Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	1	1	1			2	1		
CO 2	1		-	-	1	1	1			1	1		1
CO 3	-	-		1	2	2	1			2	2		1
CO 4	-	-			1	2	1			1	1	1	1
CO 5	-		-	1	2	2	1			2	2	1	1
CO 6	-	-	-	1	2	2	1			2	2	1	1

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 (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/viva	Quiz/seminar/ Goupdiscussion	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓		✓	✓
CO 3	✓	✓		✓
CO 4	✓		✓	✓
CO 5	✓		✓	✓
CO 6		✓	✓	