

DEPARTMENT OF CHEMISTRY				CLASS: I M.Sc. Chemistry				
Sem	Course Type	Course Code	Course Title	Credits	Contact Hours/week	CIA	Ext	Total
I	Major Core	21P1CMC3	Physical Chemistry – I	4	5	25	75	100

Nature of Course			
Knowledge and skill	✓		Employability oriented
Skill oriented			Entrepreneurship oriented

**Course Objectives:** *The objective of this course is to make the student*

- (i) *To understand chemical kinetics and explore the reaction kinetics of fast reactions.*
- (ii) *To infer knowledge on various aspects of Photochemistry, theories of reaction kinetics and mechanism involved in catalysis.*
- (iii) *To gain on understanding of the Ionic activity, ionic interactions, Debye-Hückel-Bjerrum model, Debye-Hückel limiting law.*
- (iv) *To study the Debye-Hückel theory of strong electrolytes.*
- (v) *To classify the Electrical double layer, electrocapillary phenomena, surfactants, and to study the applications of Fuel Cells, Corrosion and its Protection.*

Unit	Description	Hours	K-Level	CLO
I	<b>CHEMICAL KINETICS AND CATALYSIS</b> Absolute reaction rate theory -Thermodynamic terms-Significance of entropy Reactions in solution: factors determining reaction rates in solutions, effect of dielectric constant and ionic strength, - Bronsted – Bjerrum equation-Primary and Secondary salt effect, influence of solvent on reaction rates. Acid-base catalysis-Bronsted relations, catalytic coefficients and their determination. Enzyme catalysis and its mechanism, Michaelis-Menten equation, effect of pH and temperature on enzyme catalysis, Mechanism of enzyme inhibition kinetics of surface reactions- unimolecular reactions-Bimolecular reactions-Langmuir Hinshelwood and Elay-Rideal mechanism.	15	Up to K2	CLO-1
II	<b>CHEMICAL DYNAMICS</b> Potential energy surfaces-Dynamics of unimolecular reactions-Lindemann Hinshelwood, Rice-Ramsperger- Kassel(RRK) theory-Rice-Ramsperger-Kassel -Marcus (RRKM) theory. Study of fast reactions by stopped flow techniques- relaxation method, flash photolysis and the nuclear magnetic resonance method. Linear free energy relationship-Hammett equation, Taft equation-Separation of polar, resonance and steric effects.	15	Up to K3	CLO-2

III	<p><b>PHOTOCHEMISTRY</b>  Jablonski diagram, Primary and Secondary Processes, quantum yield and its determination-chemical actinometer. Excimers and exciplexes-Kinetics of collisional quenching-Stern Volmer equations-Photosensitization, Chemiluminescence-Photosynthesis, solar energy conversions. Semiconductor photo catalysis, lasers. Radiation Chemistry-linear energy transfer, G-value, dosimeters, radiolysis of water, solvated electrons.</p>	15	Up to K4	CLO-3
IV	<p><b>ELECTROCHEMISTRY – I</b>  Deviation from ideal behaviour.ion-solvent and ion-ion interactions. Debye-Hückel-Bjerrum model, Ion association and triple ion formations- Expression for the mean activity coefficient. Debye-Hückel limiting law and its applications -Diverse ion effect. Van't Hoff factor and its relation to colligative properties. Debye-Hückel theory of strong electrolytes. Debye-Hückel length and potential around a central ion, its interpretation. Transport of ions in Solution: Electrolytic conduction- Debye - Hückel-Onsager treatment of strong electrolytes- ionic atmosphere- Anomalous conductance of non -aqueous electrolytes.</p>	15	Up to K3	CLO-4
V	<p><b>ELECTROCHEMISTRY- II</b>  Electrical double layer - Electrocapillary phenomena - Surfactants - Lipmann's equation, Electrokinetic phenomena- Zeta potential and its applications - Structure of electrical double layer – Helmholtz-Perrin, Guoy-Chapmann and Stern models. Butler-Volmer equation for one electron transfer reaction - equilibrium and exchange current densities- and symmetry factor - transfer coefficient. Cyclic voltammetry and Stripping voltammetry - principle – instrumentation- Corrosion and passivation of metals - Pourbaix diagram - Evans diagram –Batteries and Fuel cells-Ion selective electrodes.</p>	15	Up to K4	CLO-5

#### Books for study:

1. L. R. Puri, Y. R. Sharma and R. S. Pathania, Principles of Physical Chemistry 46th Ed, 2012.
2. K. J. Laidler, Chemical Kinetics, Harper and Row, New York, 1987.
3. Rohatgi-Mukherjee, K.K., "Fundamentals of Photochemistry", Second Edition, Wiley Eastern Ltd, New York, 2011.

#### Books for reference

1. R. G. Frost and Pearson, Kinetics and Mechanism, Wiley New York, 1961.
2. Philip H. Rieger, Electrochemistry ,2nd Edition, 2010.
3. A. W. Anderson, Physical Chemistry of Surfaces, Wiley - Interscience, Newyork, 1990.
4. Paula, Peter Atkins and Julio de, Elements of Physical chemistry, 5th Ed, Oxford U. P, 2012.
5. G. L. Agarwal, Basic Chemical Kinetics, Tata McGraw Hill, 1990.
6. N. J. Turro, Modern molecular photochemistry, Benjamin/Cummings, Menlo Park, California, 1978.

## Web resources

1. [https://chem.libretexts.org/Bookshelves/General\\_Chemistry/Map%3A\\_Chemistry\\_The\\_Central\\_Science\\_\(Brown\\_et\\_al.\)/14%3A\\_Chemical\\_Kinetics/14.S%3A\\_Chemical\\_Kinetics\\_\(Summary\)](https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Chemistry_The_Central_Science_(Brown_et_al.)/14%3A_Chemical_Kinetics/14.S%3A_Chemical_Kinetics_(Summary))
2. <https://pubs.acs.org/doi/pdf/10.1021/cr60035a002>
3. [https://chem.libretexts.org/Bookshelves/Physical\\_and\\_Theoretical\\_Chemistry\\_Textbook\\_Maps/Supplemental\\_Modules\\_\(Physical\\_and\\_Theoretical\\_Chemistry\)/Spectroscopy/Electronic\\_Spectroscopy/Fluorescence\\_and\\_Phosphorescence](https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Spectroscopy/Electronic_Spectroscopy/Fluorescence_and_Phosphorescence)
4. [https://chem.libretexts.org/Bookshelves/Analytical\\_Chemistry/Supplemental\\_Modules\\_\(Analytical\\_Chemistry\)/Electrochemistry](https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Electrochemistry)

## Rationale for Nature of the course

This course will enable the students to comprehend the concepts of photochemistry, theories of kinetics, understand the basic concepts and applications of electrochemistry.

## Activities having direct bearing on Skill development/ Employability/Entrepreneurship

The basic knowledge, concepts of kinetics and electrochemistry will help the students to solve the problems related to kinetics and electrochemistry. The study of photochemistry and electrochemistry enable the students to do project related to solar cells.

## Pedagogy

- Chalk-Talk class room activities
- Seminar
- Assignment and Quiz through ICT

### Lesson Plan

Unit	Descriptions	Hours	Lecture Mode
<b>I</b>	<b>CHEMICAL KINETICS AND CATALYSIS</b>		
	Absolute reaction rate theory -Thermodynamic terms-Significance of entropy Reactions in solution:	3	Chalk and talk/PPT/ Group discussion
	factors determining reaction rates in solutions, effect of dielectric constant and ionic strength,	2	
	Bronsted -Bjerrum equation-Primary and Secondary salt effect, influence of solvent on reaction rates. Acid -base catalysis-Bronsted relations, catalytic coefficients and their determination	5	
	Enzyme catalysis and its mechanism, Michaelis-Menten equation, effect of pH and temperature on enzyme catalysis, Mechanism of enzyme inhibition kinetics of surface reactions	3	
	unimolecular reactions-Bimolecular reactions-Langmuir Hinshelwood and Elay-Rideal mechanism.	2	
<b>CHEMICAL DYNAMICS</b>			
<b>II</b>	Potential energy surfaces-Dynamics of unimolecular reactions	3	Chalk and talk/PPT/ Group discussion
	Lindemann Hinshelwood, Rice-Ramsperger- Kassel (RRK) theory. Rice-Ramsperger-Kassel -Marsus (RRKM) theory	3	
	Study of fast reactions by stopped flow techniques- relaxation method, flash photolysis and the nuclear magnetic resonance method.	4	
	Linear free energy relationship-Hammett equation, Taft equation	3	
	Separation of polar, resonance and steric effects.	2	
<b>III</b>	<b>PHOTOCHEMISTRY</b>		
	Jablonski diagram, Primary and Secondary Processes, quantum yield and its determination	3	Chalk and talk/PPT/ Animated videos/ Assignment
	chemicalactinometer. Excimers and exciplexes-Kinetics of collisional quenching-Stern Volmer equations	3	
	Photosensitization, Chemiluminescence-Photosynthesis, solar energy conversions	3	
	Semiconductor photo catalysis, lasers. Radiation Chemistry-linear energy transfer, G-value	3	
	Dosimeters, radiolysis of water, solvated electrons	3	
<b>ELECTROCHEMISTRY i</b>			
<b>IV</b>	Deviation from ideal behaviour. ion-solvent and ion-ion interactions. Debye-Hückel-Bjerrum model, Ion association and triple ion	4	Chalk and talk/PPT/ Group discussion
	Debye-Hückel limiting law and its applications -Diverse ion effect. Van't Hoff factor and its relation to colligative properties	4	
	Debye-Hückel theory of strong electrolytes.Debye-Hückel length and potential around a central ion, its interpretation	4	
	Transport of ions in Solution: Electrolytic conduction- Debye -Hückel-Onsager treatment of strong electrolytes- ionic atmosphere-	3	

<b>V</b>	<b>ELECTROCHEMISTRY II</b>		
	Electrical double layer - Electrocapillary phenomena - Surfactants - Lipmann's equation,	3	Chalk and talk/PPT/ Assignment
	Electrokinetic phenomena- Zeta potential and its applications - Structure of electrical double layer – Helmholtz-Perrin, Guoy-Chapmann and Stern models.	4	
	Butler-Volmer equation for one electron transfer reaction - equilibrium and exchange current densities- and symmetry factor - transfer coefficient.	4	
Cyclic voltammetry and Stripping voltammetry - principle – instrumentation- Corrosion and passivation of metals - Pourbaix diagram - Evans diagram – Batteries and Fuel cells-Ion selective electrodes.	4		

**Course Learning outcome:**

After successful completion of this course, the student will be able to

<b>CLOs</b>	<b>CLO statement</b>	<b>Knowledge level</b>
<b>CLO-1</b>	Summarize the theories of kinetics, and mechanism of enzyme catalysis.	Up to K2
<b>CLO-2</b>	Develop equations based on the theories and mechanisms of kinetics.	Up to K3
<b>CLO-3</b>	Illustrate the various aspects of photochemistry, radiation chemistry and its applications	Up to K4
<b>CLO-4</b>	Make use of concepts of ionic interactions, theory of electrolytes, double layer models, Debye-Hückel limiting law.	Up to K3
<b>CLO-5</b>	Analyze the problem in the concept of electrical double layers, design of Batteries, Fuel cells and ion selective electrodes	Up to K4

### Mapping of CLOs with PLOs

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
<b>CLO1</b>	3	1	3	3	2
<b>CLO2</b>	3	1	2	3	2
<b>CLO3</b>	3	1	1	3	2
<b>CLO4</b>	3	1	2	3	2
<b>CLO5</b>	3	1	3	3	2

Advance application-3;

Intermediate level-2;

Basic level-1

Components of Formative Assessment	Marks	K level
Internal Test	<b>10</b>	As per below table
Assignment	<b>5</b>	K4
Quiz	<b>5</b>	K4
Seminar	<b>5</b>	K4
<b>Total</b>	<b>25</b>	

### Learning Outcome Based Education (LOBE) & Assessment

#### Formative Examination I & II – Blue Print

#### Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)

Units	CLOs	K- Level	Section A		Section B (Either/or Choice)	Section C (Open Choice)
			Short Answers			
			No. of Questions	K- Level		
1	CLO x	Up to K3	2	K2, K3	2 (K3&K3)	2(K2/K3)
2	CLO y	Up to K4	3	K2, K2, K3	2 (K4&K4)	1(K3/K4)
No. of Questions to be asked			5		4	3
No. of Questions to be answered			5		2	2
Marks for each question			2		5	10
Total Marks for each section			10		10	20

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

**Learning Outcome Based Education (LOBE) & Assessment**  
**Summative Examination – Blue Print**  
**Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)**

S. No.	CLOs	K- Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K- Level	No. of Questions	K- Level		
1	CLO 1	Up to K 2	2	K1 & K1	1	K1	2 (K1&K1)	1(K2)
2	CLO 2	K 3	2	K2 & K3	1	K1	2 (K2&K2)	1(K3)
3	CLO 3	Up to K 4	2	K3 & K4	1	K2	2 (K4&K4)	1(K4)
4	CLO 4	Up to K 3	2	K2 & K3	1	K2	2 (K3&K3)	1(K3)
5	CLO 5	Up to K 4	2	K3 & K4	1	K3	2 (K4&K4)	1(K4)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each question			1		2		5	10
Total Marks for each section			10		10		25	30

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

**Distribution of Section-wise Marks with K Levels**

K Levels	Section A & B (No Choice)	Section C (Either / or)	Section D (Open Choice)	Total Marks	% of Marks without choice	Consolidated %
K1	6	10	-	16	13.3	35
K2	6	10	10	26	21.7	
K3	6	10	20	36	30	30
K4	2	20	20	42	35	35
<b>Total marks</b>	<b>20</b>	<b>50</b>	<b>50</b>	<b>120</b>	<b>100</b>	<b>100</b>

**Name of the course Designers**

1. Dr. M. Malarvizhi

2. Dr. R. Ramachandran