Course Code	Course Title	Credit Hours
0531-14-121	Equilibria Reaction Rates and Electrolytes	3.0

(a) Rationale:

This course covers the fundamentals of chemical equilibrium, kinetics, and electrochemistry. Topics include the law of mass action, acid–base concepts, pH, buffers, titrations, solubility, and reaction kinetics (zero and first order). It also introduces conductance, electrolysis, and electrochemical cells, providing a foundation for further study in physical chemistry.

(b) Course Objectives

- To understand the fundamental concepts of chemical equilibrium.
- To gather knowledge about acid-base concepts, pH, titration and role of indicators.
- To analyze solubility product, common ion effect and complex ion equilibria.
- To state the elementary concepts of chemical kinetics.
- To understand the fundamental concepts of electrolysis and their mechanism.

(c) Course Contents

1.	**Chemical Equilibrium:** Concept of equilibrium: activation energy, mobile equilibrium; reversible & irreversible reaction; homogeneous and heterogeneous equilibria, law of mass action; factors affecting equilibrium: Le-Chatelier's principle; free energy change and equilibrium constant; degree of dissociation; Ostwald's dilution law and fugacity, activity & activity coefficient.
2.	**Acid-Base Equilibrium:** Modern concepts of acid-base; Arrhenius, Bronsted-Lowry's, Lewis, Hard and soft, Cady-Esley, Lux-Flood and Usanovich concept; conjugate acid-base pairs, dualism of molecules; ionic product of water and pH scale; buffer solution and its mechanism; Henderson-Hasselbalch equation; relative strength of acids and bases; acid-base titration, indicators and its mode of action, theories of acid-base indicators.
3.	**Solubility and Complex Ion Equilibria:** Solubility and solubility product, common ion effect, effect of pH on solubility, precipitation, applications of solubility product principle; complex ion equilibria; complex-ion formation, complex ions and solubility.
4.	**Chemical Kinetics:** Elementary concepts of chemical kinetics; order, molecularity, rate of reaction; rate law; integration of rate equations for model reaction system; zero, first, second and fractional order reaction kinetics, Pseudo molecular reaction, half-life and average life of a reaction, methods of order calculation.
5.	**Electrolytes:** Basics of strong and weak electrolytes, electrochemical series, electrolysis and its mechanism; Faraday's law, electrolytic/electrochemical cell, cell constant. Conductance; electrolytic and metallic conductance, specific and equivalent conductance; migration of ion; transport number, Kohlrausch's law.

***(d) Course Learning Outcomes (CLOs)*:**

After completion of the Course, the student will be able to –

CLO-1: Define the fundamentals of rate of reaction and chemical equilibrium.
CLO-2: Demonstrate concepts of acid-base equilibria and their titration.
CLO-3: Articulate common ion effect, solubility product and complex ion equilibria.
CLO-4: Interpret reaction kinetics and their methods.
CLO-5: Draw the electrolytic and electrochemical cell using cell reactions.

(e) Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs):

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	-	2	3	-	-	-	-	-	-
CLO2	3	-	3	3	-	-	-	-	-	-

CLO3	3	-	3	3	-	-	-	-	-	-
CLO4	3	-	-	3	-	-	-	-	-	-
CLO5	3	-	3	3	-	-	-	-	-	-

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

(f) Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy		
CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Student Activity	Quiz
CLO2	Lecturing and Discussion	Quiz and Summative Exam
CLO3	Lecturing and Discussion	Mid-Semester and Assignment
CLO4	Lecturing and Group Discussion	Summative Exam
CLO5	Student Activity and Discussion	Mid-Semester and Summative

(g) Learning Materials
(i) Recommended Readings
• Haque M. M., Mollah M. Y. A., *Principles of Physical Chemistry*, Brother's publications
• Glasstone S., *A Text Book of Physical Chemistry*, 2nd ed., Macmillan & Co. Ltd., London.
(ii) Supplementary Readings
• Glasstone S., *An Introduction to Electrochemistry*, Norman Oxlahoma Press.
• Laidler K. J., *Chemical Kinetics,* 3rd edition; Dorling Kindersely Pvt. Ltd.
• Atkins P., Paula J.de, *Physical Chemistry*, 10th edition; Oxford University Press.
• Barrow G.M., *Physical Chemistry*, 5th edition, Tata McGraw Hill Education Pvt. Ltd.
• Maron S. H., Lando J. B., *Fundamental of Physical chemistry*, Macmillan Publishing Co.
• Castellan G.W., *Physical Chemistry*, 3rd edition; Narosa Pub. House, Delhi.
• Kundu N., Jain S. K., *Physical Chemistry*, S. Chand & Co, New Delhi.

(h) Evaluation Strategy

Each theoretical course offered should be composed of either 50 (for 02 credits) or 100 (for 03 credits) marks. Grades will be calculated as per the university grading structure and individual student will be evaluated based on the following criteria with respective weights.

Descriptions	**Evaluation (%)**
Class Test and/or Quiz and/or In-course and/or Sudden test and/or tutorial	10%
Assignment and/or Presentation with Rubrics	05%
Mid Semester Examination (At least 2 mid-semester examinations). An average of all examinations will be calculated.	20%
Semester-Final Examination: An Average of the marks given by the internal and external examiners will be calculated.	60%
Total:	**100%**

(i) Course plan specifying content, CLOs, co-curricular activities (if any), TL and assessment strategy mapped with CLOs.

Week	**Topic**	**Teaching Learning Strategy**	**Assessment Strategy**	**Corresponding CLOs**
1	Introduction to Chemical Thermodynamics.	Lecturing	Course preparatory quiz	CLO1

2	1st law of thermodynamics; system; different processes. **(Ch 1)**	Lecturing & discussion	Midterm-I and Final Exam. (Summative)	
3	Work done in different processes; heat capacities; Joule-Thomson effect. **(Ch 1)**	Demonstration & lecturing		
4	Thermochemistry; thermochemical laws; Kirchhoff's equation; bond energy; lattice energy. **(Ch 2)**	Lecturing & discussion	Assignment (with Rubrics) & Final Exam. (Summative)	CLO2
5	Review of 1st law of thermodynamics & Thermochemistry. **(Ch 1 & 2)**	Review & Discussion	Final Exam. (Summative)	CLO1 & CLO2
6	Second law of thermodynamics; Carnot's cycle. **(Ch 3)**	Lecturing & discussion	Midterm-II & Final Exam. (Summative)	CLO3 & CLO4
7	Entropy and free energy; Gibbs and Helmholtz free energy; network work done. **(Ch 3)**	Lecturing & discussion		
8	Condition of spontaneity; Gibbs-Helmholtz; Clapeyron and Clausius-Clapeyron equations. **(Ch 3)**	Lecturing & discussion		
9	Van't-Hoff reaction isotherm and isochors; Maxwell's relations. **(Ch 3)**	Lecturing & discussion		
10	3rd law of thermodynamics; Nernst heat theorem. **(Ch 4)**	Lecturing & discussion		CLO5
11	Absolute entropy; entropy and probability; entropy calculation for gaseous substance. **(Ch 4)**	Lecturing & discussion		
12	Partial molar quantities; intercept method. **(Ch 4)**	Demonstration & lecturing		
13	Gibbs-Duhem; Duhem-Margules; Konowaloff's rule; Raoults law. **(Ch 4)**	PPT presentation & discussion		
14	Review of Thermodynamics & thermochemistry. **(Ch 1 to 4)**	Discussion & Review	Quiz/presentation (Formative)	CLO1 to CLO5