

SRM Institute of Science and Technology

Faculty of Engineering and Technology

Department of Chemical Engineering

Course Code & Title: **15CH207J Physical and Analytical Chemistry**

Course Strategy Description

Course description:

The course helps the students to acquire basic knowledge of chemical principles which form the foundation for understanding separation operations. It also provides the basic information on the analytical tools used in research.

Compulsory/Elective course: Compulsory for B.Tech. Chemical Engineering

Credit hours: 4 credits (3 theory + 1 lab)

Course coordinator(s): Dr. K. Deepa, Research Assistant Professor, Department of Chemical Engineering

Instructor(s):

Name of the instructor	Room number	Email (@ktr.srmuniv.ac.in)	Consultations (day order/periods)
Dr. M. P. Rajesh	HoD office	hod.chem	Day – 5: 3 and 4
Dr. K. Deepa	CRE lab	deepa.ka	Day – 5: 2 and 3

Relationship to other courses

Course category: Professional core

Prerequisite: Nil

Co-requisite: Nil

Following courses: Nil

Text book(s) and/or required materials:

1. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 47th Ed, 2015, ISBN-13: 978-9382956785

Reference book(s):

2. Frank R. Foulkes, Physical Chemistry for Engineering and Applied Sciences, 2012, CRC Press, ISBN 9781466518469

Class schedule: G Slot; Three 50 minutes lecture sessions and three hours laboratory per week, for 15 – 16 weeks

DAY ORDER: HOUR	TIMING
DAY - 1: 2, 3, AND 4 (LAB)	8.50 AM -11.30 AM
DAY - 2: 3 AND 4	9.45 AM - 11.30 AM
DAY - 4: 5	11.35 AM - 12.25 PM

Instructional Objectives (IOs) and Student Outcomes (SOs)

S.No.	Instructional Objectives	Student Outcomes				
1.	Understand the physical and physico-chemical principles behind the behavior of fluids. Realize the situations where systems behave ideally – recognize the non -ideality and the reasons for such behavior.	a	b			
2.	Estimation of properties useful for design of separation units.	e				
3.	Realise the difference in behavior of different states of matter essential for separation operations.	c				
4.	Know the principles of analytical instruments along with their limitations.	c				
5.	Linkage of theory and practice in physical chemistry.	e				

Teaching plan

Section	Topics	L / T	Text book/chapter	IOs	SOs	Problem solving (Y/N)
UNIT I: GASEOUS STATE		9				
1 - 2	Ideal - non ideal gases, mean free path, Knudsen flow, root mean-square-velocity - expansion & compressibility – collision number – diameter-frequency – mean free path – Knudsen gas	2	[1] Chapter – 9	1-4	a,b	Y
3-5	Transport properties – general equations – expressions for thermal conductivity, viscosity and collision number (derivation not required) – deviation of real gases from ideal state- equation of state for real gases – intermolecular forces dipole-dipole, induced dipole-induced dipole – Lennard-Jones potential.	3	[1] Chapter – 9,10	1	a,b	N
6-8	Critical phenomenon – critical pressure, volume and temperature - PV diagram of CO ₂ – law and principle of corresponding states- JT effect - liquefaction of gases.	3	[1] Chapter –10	1	a,b	Y
9	Recap – linkage of various concepts and their relevance to unit operations.	1	[1] Chapter – 9,10	1	a,b	N
UNIT II: LIQUID STATE		9				
1-3	Liquid state: Vapor pressure – surface tension – viscosity – solutions of non electrolytes - Raoult's law, ideal and non-ideal solutions, vapor pressure and boiling point diagrams of completely miscible binary solutions - completely immiscible liquids: steam distillation and its application.	3	[1] Chapter – 11,21	2	e	Y
4-6	Solubility of partially miscible liquids - upper and lower critical solution temperature, solubility of gases in liquids: factors affecting solubility, Henry's law.	3	[1] Chapter – 21	2	e	N
7-9	Colligative Properties, concepts of vapor pressure lowering, osmosis and osmotic pressure, boiling point elevation, freezing point depression - determination of molecular weight from colligative properties - reverse osmosis - effect of association/dissociation on colligative properties	3	[1] Chapter – 22	2	e	Y

UNIT III: CHEMICAL EQUILIBRIUM AND PHASE RULE		9				
1-3	Chemical kinetics: order/molecularity of a reaction, reaction rate, integrated equations of rate laws for zeroth to n th order, half time for all orders	3	[1] Chapter – 28	4	c	Y
4-6	Chemical Equilibrium: Free energy – law of mass action – derivation – law of Chemical equilibrium – meaning and relationship between K_p , K_c & K_x , (derivations not required) - temperature dependence of Equilibrium constant - Van't Hoff Equation – pressure dependence of equilibrium constants – Le Chatelier's Principle and physical equilibria	3	[1] Chapter – 17	4	c	Y
7-9	Phase Equilibria : Definition of component, phase and degrees of freedom, derivation of phase rule, one component system (water and CO ₂), triangular phase diagram - three component system (acetic acid, chloroform and water; two salts and water)	3	[1] Chapter – 18	4	c	Y
UNIT IV: SURFACE PHENOMENON AND PHOTOCHEMISTRY		9				
1-3	Introduction and properties of colloidal systems, gels and emulsions (no preparation) – electrical & electro-kinetic properties – concept of zeta potential – mobility of colloids - electrophoresis and electro-osmosis reaction	3	[1] Chapter – 32	4	c	N
4-6	Sorption by solids – adsorption and chemi-sorption – applications of adsorption- factors influencing adsorption – effect of temperature and pressure – Freundlich, Langmuir and BET isotherms - distinguishing features – Determination of surface area types of adsorption isotherms	3	[1] Chapter – 33	4	c	Y
7-9	Laws of photochemistry, quantum efficiency, actinometry, photochemical reactions, photochemical rate law - determination of quantum yields - kinetics of hydrogen-chlorine reaction - primary and secondary processes – comparison with hydrogen-bromide	3	[1] Chapter – 29	4	c	Y
UNIT V: INSTRUMENTAL METHODS OF ANALYSIS						
1-3	Terms associated with analytical techniques – accuracy/precision- common errors (system/manual) – calibration curves - basics of classification of instrumental methods - spectroscopy, electrochemical and	3	Internet source	4	c,e	N

	chromatography, advantages and limitations of instrumental analysis - electro-magnetic (EM) spectrum – interaction of EM radiation with matter – laws of absorption – Generalities of optical methods (light source/ monochromator / sample introduction / detector / signal generator) - selection of techniques for quantitative/qualitative analysis					
4-5	UV –Vis spectroscopy- instrumentation – measurements - applications - instrumentation and applications of IR spectroscopy - instrumentation and applications of emission and atomic absorption spectrophotometers	2	Internet source	4	c,e	N
6-8	Gas Chromatography- types (GS and GL) - principles of gas chromatographic separations - description of instrument, role of components and working philosophy – examples for qualitative and quantitative analysis- advantages and limitations - principles of HPLC – instrument description – applications	3	Internet source	4	c,e	N
9	Criteria for selection of techniques for quantitative/qualitative analysis	1	Internet source	4	c,e	N

Evaluation methods

S.No.	Test	Topics covered	Marks	Test/Exam duration (min)
1.	Cycle test – I	Units I and II	15	100
2.	Cycle test – II	Units III, IV and V	25	180
3.	Surprise test	Questions from any unit	5	20
4.	Assignment	Questions from any unit	5	-
5.	Final exam	All the units	50	180

Surprise test

The surprise test will not be announced. The questions for this test will be covered until the previous class.

Home assignments

A few units will have home assignment. All the assignments should be submitted on or before the last date of submission.

Teaching Methodology

Chalk and talk for the first four units; PowerPoint presentation for the 5th unit.

Prepared by: Dr. K. Deepa, Research Assistant Professor, Department of Chemical Engineering

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Date of revision:

Revised by:

Course Coordinator

Academic Coordinator

HoD/Chemical