

UNIVERSITY OF MADRAS
B.Sc. DEGREE PROGRAMME IN CHEMISTRY
 SYLLABUS WITH EFFECT FROM 2023-2024

Title of the Course	PHYSICAL CHEMISTRY-II						
Paper No.	Core XV (CC – 15)						
Category	Core	Year	III	Credits	4	Course Code	324C6C
		Semester	VI				
Instructional hours per week	Lecture	Tutorial	Lab Practice		Total		
	4	1	-		5		
Prerequisites	Physical Chemistry - I						
Objectives of the course	<p>The course aims at providing an overall view of the</p> <ul style="list-style-type: none"> • phase diagram of one and two component systems • chemical equilibrium, • separation techniques for binary liquid mixtures. • electrical conductance and transport number. • galvanic cells, EMF and significance of electrochemical series. 						
Course Outline	<p>UNIT-I Phase rule Definition of terms; derivation of phase rule ; application to one component systems – water and sulphur - super cooling, sublimation ; two component systems – solid liquid equilibria- simple eutectic (lead - silver and bismuth - cadmium), freezing mixtures (potassium iodide- water), compound formation with- congruent melting points (magnesium – zinc and ferric chloride – water system), peritectic change (sodium potassium), solid solution(gold-silver); copper sulphate-water system</p>						
	<p>UNIT II Chemical equilibrium Law of mass action – thermodynamic derivation – relationship between K_p and K_c –application to the homogeneous equilibria – dissociation of PCl_5 gas, N_2O_4 gas –equilibrium constant and degree of dissociation - formation of HI, NH_3, and SO_3 –heterogeneous equilibrium – decomposition of solid calcium carbonate –Lechatelier principle – van't Hoff reaction isotherm – temperature dependence of equilibrium constant – Van't Hoff reaction isochore – Clapeyron equation – Clausius Clapeyron Equation and its applications</p> <p>UNIT III Binary liquid mixtures Ideal liquid mixtures – non ideal solutions – azeotropic mixtures – fractional distillation – partially miscible mixtures – phenol-water, triethylamine-water, nicotine-water – effect of impurities on critical solution temperature; immiscible liquids- steam distillation; Nernst distribution law – applications.</p>						

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UNIT IV

Electrical Conductance and Transference

Arrhenius theory of electrolytic dissociation – Ostwald's dilution law, limitations of Arrhenius theory; behavior of strong electrolytes – interionic effects – Debye Huckel theory – Onsager equation (no derivation), significance of Onsager equation, Debye Falkenhagen effect, Wien effect. Ionic mobility – Discharge of ions on electrolysis (Hittorf's theoretical device), transport number – determination – Hittorf's method, moving boundary method – factors affecting transport number – determination of ionic mobility; Kohlrausch's law – applications; molar ionic conductance and viscosity (Walden's rule); applications of conductance measurements – determination of - degree of dissociation of weak electrolyte, dissociation constant of weak acid and weak base, ionic product of water, solubility and solubility product of sparingly soluble salts - conductometric titrations – acid base titrations.

UNIT V

Galvanic Cells and Applications

Galvanic cell, representation, reversible and irreversible cells, EMF and its measurement – standard cell; relationship between electrical energy and chemical energy; sign of EMF and spontaneity of a reaction, thermodynamics and EMF – calculation of ΔG , ΔH , and ΔS from EMF data; reversible electrodes, electrode potential, standard electrode potential, primary and secondary reference electrodes, Nernst equation for electrode potential and cell EMF; types of electrodes – metal/metal ion, metal amalgam/metal ion, metal, insoluble salt/anion, gas electrode, redox electrode; electrochemical series – applications of electrochemical series. Chemical cells with and without transport, concentration cells with and without transport;

Applications of EMF measurements

applications of EMF measurements – determination of activity coefficient of electrolytes, transport number, valency of ions, solubility product, pH using hydrogen gas electrode, quinhydrone electrode and glass electrode, potentiometric titrations – acid base titrations, redox titrations, precipitation titrations, ionic product of water and degree of hydrolysis; redox indicators - use of diphenylamine indicator in the titration of ferrous iron against dichromate.

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<p>Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)</p>	<p>Questions related to the above topics, from various competitive examinations UPSC/ JAM /TNPSC others to be solved (To be discussed during the Tutorial hours)</p>
<p>Skills acquired from this course</p>	<p>Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.</p>
<p>Recommended Text</p>	<ol style="list-style-type: none"> 1. B.R. Puri and L.R. Sharma, Principles of Physical Chemistry, ShobanLal Nagin Chand and Co., forty eighth edition, 2021. 2. Peter Atkins, and Julio de Paula, James Keeler, Physical Chemistry, Oxford University press, International eleventh edition,2018. 3. ArunBahl, B.S. Bahl, G. D. Tuli Essentials of physical chemistry, 28thedition 2019, S, Chand &Co. 4. S. K. Dogra and S. Dogra, Physical Chemistry through Problems: New Age International, fourth edition, 1996. 5. J. Rajaram and J.C. Kuriacose, Thermodynamics, ShobanLal Nagin Chand and CO.,1986.
<p>Reference Books</p>	<ol style="list-style-type: none"> 1. K. L. Kapoor, A Textbook of Physical Chemistry, Macmillan India Ltd, thirddedition,2009. 2. Gilbert. W. Castellen, Physical Chemistry, Narosa Publishing House, third edition,1985. 3. P. W. Atkins, and Julio de Paula, Physical Chemistry, Oxford University press, seventh edition,2002. 4. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, Shobanlal Nagin Chand and Co. Jalendhar, forty first, edition,2001 5. D.N.Bajpai, Advanced Physical Chemistry, S.Chand &Co., 2001
<p>Website and e-learning source</p>	<p>https://nptel.ac.inhttps://swayam.gov.in https://archive.nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/M TS_07_m.pdf Thermodynamics - NPTEL https://www.youtube.com/watch?v=f0udxGcoztE Introduction to chemical equilibrium – MITopencourse ware</p>

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Course Learning Outcomes (for Mapping with POs and PSOs) On

completion of the course the students should be able to

- CO1:** construct the phase diagram for one component and two component systems, explain the properties of freezing mixture, component with congruent melting points and solid solutions.
- CO2:** apply the concepts of chemical equilibrium in dissociation of PCl_5 , N_2O_4 and formation of HI , NH_3 , SO_3 and decomposition of calcium carbonate. Demonstrate important principles such as Le chatelier principle, van't Hoff reaction isotherm and Clausius-Clayperon equation.
- CO3:** Identify an appropriate distillation method for the separation of binary liquid mixtures such as azeotropic mixtures, partially miscible mixtures and immiscible liquids.
- CO4:** Explain the significance of Arrhenius theory, Debye-Huckel theory, Onsager equation and Kohlrausch's law in conductance.
- CO5:** Construct electrochemical cell with the help of electrochemical series and calculate cell EMF. Demonstrate the applications of EMF and significance of potentiometric titrations.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	M	S	M
CO2	M	S	S	S	M	S	S	M	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix)

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's