Course code	Course Name	L-T-P-Credits	Year of Introduction
CH208	CHEMISTRY FOR PROCESS ENGINEERING -II	3-0-0-3	2016

Prerequisite: CH207 Chemistry for process engineering - I

Course Objectives

1. To impart the knowledge of analytical and physical chemistry relevant to the field application of Chemical Engineering
2. To comprehend the contemporary techniques in analytical and physical chemistry that are applied to many areas of chemical research

Syllabus

Electro-analytical chemistry, potentiometry, voltammetry, electrogravimetry, electrochemical sensors; Mass spectrometry, atomic absorption & emission spectroscopy and surface analysis techniques; Phase equilibria, principles of solvent extraction; electrolytic conductions and electrolytic processes; Adsorption and surface chemistry, emulsions and surfactants; Nuclear stability, radioactivity, analytical and medicinal applications of nuclear chemistry.

Expected Outcome

At the end of the course students will be able to:

(i) Describe basic principles of electrochemistry

(ii) Summarize spectroscopy, surface analysis techniques and solubility behaviour

(iii)Interpret phase equilibria and electrochemical equilibria towards different chemical engineering applications.

References:

1. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8th edition, Saunders College Pub., 2007.
2. H.H. *Willard, L.L. Merritt Jr. J.A. Dean,* F. A. Settle *Jr*., 7th ed., Wadsworth Publishing Co., 1988.
3. G.R. Chatwal, S.K. Anand, Instrumental Methods of Chemical Analysis, 5th edition, Himalaya, 2007.
4. B. R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 2013.
5. J. Koryta, J. Dvorak, L. Kavan. Principles of electrochemistry, 2nd edition, John Wiley & Sons, Inc. 1993.
6. D. Harvey, Modern analytical chemistry, McGraw-Hill, Inc. 2000.
7. J. A. C. Broekaert, Analytical Atomic Spectrometry with Flames and Plasmas, Wiley-VCH, 2002.
8. P. Atkins, J. de Paula, Elements of Physical Chemistry, 5th edition, Oxford University Press, 2009.
9. P. J. Gellings, H. J. M. Bouwmeester (editors), The CRC handbook of solid state electrochemistry, CRC Press, Inc., 1996.
10. J. Wang, Analytical Electrochemistry, 2nd edition, Wiley-VCH, 2000.
11. W. Adamson, A. P. Gast, Physical Chemistry of Surfaces, 6th edition, Wiley-Interscience, 1997.

12. D. Myers, Surfaces, Interfaces, and Colloids, 2nd edition, Wiley-VCH, 1999.
13. W. D. Loveland, D. J. Morrissey, G. T. Seaborg, Modern nuclear chemistry, John Wiley & Sons, Inc., 2006.
14. G. Friedlander, J. W. Kennedy, E. S. Macias, J. M. Miller, Nuclear and radiochemistry, 3rd edition, John Wiley & Sons, Inc. 1981.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Electro-analytical chemistry** Potentiometry – Principle, determination of equivalence points for acid–base, complexation, redox, and precipitation titrations. Voltammetry -Residual current, migration current, diffusion current (Ilkovic equation) and limiting current. Polarographic waves (anodic and cathodic), Half wave potentials. Dropping mercury electrode (DME). Anodic stripping voltammetry. Amperometry. Coulometric titrations. Electrogravimetry.	6	15%
II	**Spectroscopic and surface analysis technique** Principle, instrumentation and applications of mass spectrometry, atomic absorption spectroscopy (AAS), atomic emission spectroscopy (AES), X–ray photoelectron spectroscopy (XPS), auger electron spectroscopy (AES), scanning electron microscopy (SEM), scanning tunneling electron microscopy (STEM)and atomic force microscopy (AFM).	6	15%
FIRST INTERNAL EXAMINATION			
III	**Phase equilibria** Nernst distribution law (thermodynamic derivation), association and dissociation of solute, chemical combination of solute with solvent. Application of Nernst distribution law, principles of solvent extraction, Parke's process. Numerical problems of distribution law. Solubility of partially miscible liquids. Critical solution temperature. Phenol – water, triethylamine – water and nicotine – water systems. Distillation of immiscible liquids – steam distillation – applications	**7**	15%
IV	**Electrochemistry** Conductivity of electrolytes, Arrhenius theory of weak electrolytes, Kohlrausch law, Debye–Hückel theory (basics	**7**	15%

	only). Transport (transference) number,Hittorf's method. Concentration cells (with and without transference), Liquid junction potential. Cathodic hydrogen evolution - hydrogen overvoltage. Anodic oxygen evolution, Cathodic Oxygen reduction. Electrochemical sensors (Biosensors for glucose, ethanol and urea, gas sensors for Oxygen and CO_2).Electrochromism and electrochromic devices (e.g. tungsten oxide).		
SECOND INTERNAL EXAMINATION			
V	**Adsorption and Surface Chemistry** Adsorption Isotherms – Langmuir, Freundlich and BET equations (no derivation for BET). Determination of surface area using BET equation. Gibbs surface excess. Gibbs adsorption isotherm – derivation. Colloids – classification, preparation and purification. Protective colloids. Zeta potential, Donnan membrane equilibrium. Dorn effect. Emulsion – properties and applications. Surfactants - types and uses	8	20%
VI	**Nuclear and radiochemistry** Nuclear stability and radioactivity, types of radioactive decays. Binding energy and decay schemes, first order decay expressions. Consecutive decays, transient & secular equilibria. Nuclear reaction cross-section.Liquid drop model of nuclear fission and fissionability parameters. Neutron activation analysis. Medical isotopes and treatment. Tracers, isotope separation, dating techniques. Isotope effects.	8	20%
END SEMESTEREXAMINATION			

Evaluation Scheme

- **Internal Evaluation: Total Marks: 50**
  (i) *Total Marks for Assignment/Seminar/Project/Case study or any other appropriate tool used for the evaluation of the course outcomes:* **10**
  A minimum of above two tools shall be used. If more than 2 tools are used, proportionate change shall be made in the marks so that the total contribution of marks for item (i) above remains at 10.
  (ii) Marks for Tests: Two tests each carrying 40% weightage shall be conducted with total contribution of **40 marks**.

- **External Evaluation :** University Examination
  Maximum Marks : 100
  Exam Duration : 3 Hours

Question Paper Pattern:

There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.

(2 x15= 30 Marks)

There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.

(2 x15= 30 Marks)

There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together.

(2 x20= 40 Marks)