Chemistry – II
(Semester 3)

Environmental and Physical Chemistry

Part-1: Environmental Chemistry

Course Objectives:
Students will be able to acquire knowledge and develop understanding about the fundamental principles of environmental chemistry and different types of pollutions. Such information will be useful in studying and solving pollution related issues and experiments in the laboratory.

Course Contents:
Atmospheric Pollution:
The atmosphere, composition, temperature and pressure profile, role of free radicals in the atmosphere, temperature inversion and photochemical smog, particulate matter in the atmosphere, Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation, global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone–the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Water Pollution:
Water pollution and waste water treatment, municipal, industrial and agricultural sources of pollution, heavy metals contamination of water, eutrophication, detergents and phosphates in water, water quality criteria, water purification: primary, secondary and advanced treatment, removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Land pollution:
Soil and mineral resources, general principles of metal extraction, heavy metals contamination of soil, toxicity of heavy metals, bio-accumulation of heavy metals, organic matter in soil, macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Chemistry:
Atom economy, integrated pests management control (IPMC), ionic liquids, super critical extraction technology, green synthesis, recycling, carbon dioxide sequestering, water based paints.

Part-2: Physical Chemistry

Course Objectives:
Students will acquire knowledge to enable themselves to understand the fundamental principles and laws of thermodynamics and chemical equilibria and to investigate the physical properties of ideal/non-ideal binary solutions. Students will also be able to study the rates of reactions and perform related calculations.

Chemical Thermodynamics:
Equation of states, ideal and real gases, the virial equation and the van der Waals equation for real gases, critical phenomena and critical constants, four laws of thermodynamics and their

applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and non-reversible processes, spontaneous and non-spontaneous processes, relations of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, fugacity and activity.

Chemical Equilibrium:
General equilibrium expressions, reaction quotients, examples of equilibrium reactions in solid, liquid and gas phases, extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, effect of temperature and pressure on the equilibrium constants/compositions, van't Hoff equation, Le-Chatelier's principle.

Solution Chemistry:
Physical properties of liquids, surface tension, viscosity, refractive index, dipole moment etc. and their applications, brief account of interactions among the molecules in liquids, ideal and non-ideal solutions, Raoult's law and its applications, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, vapor pressure of non-ideal solutions and Henry's law, abnormal colligative properties, degrees of association and dissociation of solutes, osmotic pressure and its measurement, fractional distillation and concept of azeotropic mixtures.

Chemical Kinetics:
The rates of reactions, zero, first, second and third order reactions with same and different initial concentrations, half-lives of reactions, experimental Techniques for rate determination and methods for determination of order of reaction (integration, half-life, initial rate, and graphical methods), Arrhenius equation.

CHEM-171 Lab.
- Determination of viscosity and refractive index of liquids.
- Determination of percent composition of liquid solutions viscometrically.
- Determination of refractive index and molar refractivity.
- Determination of percent composition of liquid solutions by refractive index measurements.
- Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
- Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
- Determination of heat of solution by solubility method. Determination of heat of neutralization of an acid with a base. Kinetic study of acid catalyzed hydrolysis of ethyl acetate.
- Determination of partition coefficient of a substance between two immiscible liquids.

Recommended Books (Part-1):
Baird, C. & Cann, M. (2012). *Environmental Chemistry*, 5th ed., W. H. Freeman & Company.

Dara, S. S. & Mihsra, D. D. (2004). *A Text Book of Environmental Chemistry and Pollution Control*, 9th ed., S. Chand & Co. Ltd.

Elsom, D. M. (1992). *Atmospheric Pollution: A Global Problem*, 2nd ed., Wiley-Blackwell.

Girard, J. E. (2010). *Principles of Environmental Chemistry*, 2nd ed., Jones and Bartlett publishers.

Harrison, R. M., Monks, P., Farmer, J. G., Graham, M. C., Mora, S. J., Pulford, I. & Hulsal, C. (2007). *Principles of Environmental Chemistry,* 1st ed., Royal Society of Chemistry.

Holloway, A. M. & Wayne, R. P. (2010). *Atmospheric Chemistry,* 1st ed., Royal Society of Chemistry.

Manahan, S. E. (2009). *Environmental Chemistry,* 9th ed., CRC press, Taylor & Francis group. USA.

Matalack, A. (2010). *Introduction to Green Chemistry,* 2nd ed., CRC press, Taylor & Francis group, USA.

O'Neill, P. (1998). *Environmental Chemistry,* 3rd ed., Blackie Academic & Professional.

Singhi, R. & Singh, V. (2011). *Green Chemistry for Environmental Remediation,* John-Willey & Sons, Inc.

Vaclavikova, M., Vitale, K., Gallios, G. P. & Ivanicova, L. (2010). *Water Treatment Technologies for Removal of High Toxicity Pollutants*, Springerlink, UK.

Wright, J. (2003). *Environmental Chemistry,* Routledge.

Recommended Books (Part-2):

Atkins, P., & Jones, L. (2010). Chemical Principles: The Quest for Insight, 5th ed., W.H. Freeman, New York.

Atkins, P. & Paula, J.D. (2010). Atkin's Physical Chemistry, 9th ed., Oxford University Press.

Chaudhary, S. U. (2013). Ilmi Textbook of Physical Chemistry, 2nd ed., Ilmi KitabKhana, Lahore.

Davis, W. M., & Dykstra, C. E. (2011). Physical Chemistry: A Modern Introduction, 2nd ed. CRC Press.

Glasstone, S. (1960). *Textbook of Physical Chemistry*, Macmillan London.

James, A. M., & Prichard, F. E. (1974). Practical Physical Chemistry, 3rd ed., Longman Group Limited, New York.

Linder, B. (2011). Elementary Physical Chemistry, World Scientific Publishing Co. Ptv. Ltd.

McQuarrie, D. A. & Simon, J. D. (1997). Physical Chemistry – A Molecular Approach, 1st ed., University Science Books. Publishing Company Limited.

Shoemaker, D. (2003). Experiments in Physical Chemistry, 8th ed., McGraw Hill.

Silbey, R., Alberty, R. & Bawendi, M. (2005). Physical Chemistry, 4th ed.