

## DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4): Nuclear and Environmental Chemistry

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nuclear and Environmental Chemistry (DSE-4)	04	03	--	01	Class 12 <sup>th</sup> with Physics, Chemistry	--

### Learning Objectives

The Objectives of this course are as follows:

- To make students know more about nuclear chemistry
- To familiarise the students about environmental chemistry, especially with respect to air and water

### Learning outcomes

By studying this course, the students will be able to:

- Gain knowledge about Nuclear chemistry, radioactive decay, nuclear disasters, and nuclear waste and their disposal.
- Describe the composition of air, various air pollutants, effects and control measures of air pollutants.
- List different sources of water, water quality parameters, impacts of water pollution, water treatment.
- Identify different industrial effluents and their treatment methods.

### SYLLABUS OF DSE-4

**Unit-1 : Nuclear Chemistry**

**(21 Hours)**

The nucleus: subatomic particles, e liquid drop model; forces in nucleus-mesons; stability of nucleus-n/p ratio, binding energy; radioactive elements.

Radioactive decay-  $\alpha$ -decay,  $\beta$ -decay,  $\gamma$ -decay; neutron emission, positron emission; unit of radioactivity (curie); half life period; radioactive displacement law, radioactive series.

Measurement of radioactivity: ionization chamber, Geiger Counters, Scintillation counters.

Nuclear reactions: Nuclear fission-theory of nuclear fission; chain reaction; nuclear fusion; nuclear reactors-fast breeder reactors, fuels used in nuclear reactors, separation of isotopes, moderators, coolants; nuclear reactors in India.

Applications: Dating of rocks and minerals, carbon dating, neutron activation analysis, isotopic labeling studies, nuclear medicine-  $^{99m}\text{Tc}$  radio pharmaceuticals.

Nuclear disasters – Chernobyl disaster, Three Mile Island Disaster, Disposal of nuclear waste and its management.

## **UNIT – 2: Air Pollution**

(12 Hours

Major regions of atmosphere, chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature, Major sources of air pollution, Pollution by  $\text{SO}_2$ ,  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{H}_2\text{S}$  and other foul-smelling gases, methods of estimation of  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{SO}_x$  and control procedures.

Chemistry and environment impact of the following: Photochemical smog, Greenhouse effect, Ozone depletion

Air pollution control, Settling Chambers, Venturi Scrubbers, Electrostatic Precipitators (ESPs).

## **UNIT – 3 : Water Pollution:**

(12

Hours)

Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological cycle and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for wastewater, industrial water and domestic water.

### **Practical component**

**Practical:**

**Credits: 01**

**(Laboratory periods:15 classes of 2 hours each)**

**(At least four experiments to be performed)**

1. Determination of dissolved oxygen in a given sample of water.
2. Determination of Chemical Oxygen Demand (COD) in a given sample of water.
3. Determination of Biological Oxygen Demand (BOD) in a given sample of water.

- Measurement of chloride, sulphate and salinity of water samples by simple titration method ( $\text{AgNO}_3$  and potassium chromate).
- Estimation of total alkalinity of water samples ( $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$ ) using double titration method.
- Measurement of dissolved  $\text{CO}_2$  in a given sample of water.
- Determination of hexavalent Chromium Cr(VI) concentration in tannery wastes/ waste water sample using UV-Vis spectrophotometry technique.

### Essential/recommended readings

#### Theory:

- Stanley E. Manahan, 10th edition, **Environmental chemistry**, CRC Press, Taylor and Francis Group, US, 2017
- Baird, C. and Cann, M., **Environmental Chemistry**, (2012), Fifth Edition, W. H. Freeman & Company, New York, US.
- VanLoon, G.W. and Duffy, J.S. (2018) **Environmental Chemistry - A global perspective**, Fourth Edition, Oxford University Press
- Brusseau, M.L.; Pepper, I.L. and Gerba, C., (2019) **Environmental and Pollution Science**, Third Edition, Academic Press.
- Masters, G.M., (1974) **Introduction to Environmental Science and Technology**, John Wiley & Sons.
- Masters, G.M., (2015) **Introduction to Environmental Engineering and Science**. JPrentice Hall India Learning Private Limited.
7. Arnika, H.J., (1987), Second Edition, **Essentials of Nuclear Chemistry**, Wiley Blackwell Publishers
- Arnika, H.J.; Rajurkar, N. S., (2016) **Nuclear Chemistry through Problems**, New Age International Pvt. Ltd.
- De, A.K. (2012), **Environmental Chemistry**, New Age International Pvt., Ltd.
- Khopkar, S.M. (2010), **Environmental Pollution Analysis**, New Age International Publisher.
- Das, A. K. (2010), **Fundamentals of Inorganic Chemistry**, Volume 1, Second Edition, CBS Publishers & Distributors Pvt Ltd.
- Das, A. K. (2012), **Environment Chemistry with Green chemistry**, Books and Allied (P) Ltd.

#### Practical:

- Vowles, P.D.; Connell, D.W. (1980), **Experiments in Environmental Chemistry: A Laboratory Manual**, Vol.4, Pergamon Series in Environmental Science.
- Gopalan, R.; Anand, A.; Sugumar R.W. (2008), **A Laboratory Manual for Environmental Chemistry**, I. K. International.

**Note:** Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.