BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

ugdSECOND SEMESTER 2020-21
COURSE HANDOUT

Date: 15.01.2021

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **CHEM F430**
Course Title : **Atmospheric Chemistry**
Instructor-in-Charge : **Shamik Chakraborty**

1. Course Description: Measures of atmospheric compositions, Atmospheric pressure, Models to explain variation in concentration of chemical species in atmosphere, Atmospheric transport, Continuity equation to provide quantitative measures about the variation of concentration of various chemical species in atmosphere, Geochemical cycles, Photochemistry, the Green House Effect, Aerosols, Chemical Kinetics, Stratospheric ozone, Oxidation in troposphere, Ozone air pollution, Acid rain.

2. Scope and Objective of the Course: The fundamental concepts of Atmospheric Chemistry would be provided in this course in a systematic and organized manner. Simple principles of mathematics, physics, and chemistry would be employed to describe a complex system, such as, atmosphere. The complexity of the system would be reduced logically to develop various models. The fundamental knowledge of atmospheric chemistry, along with the description of experiments that lead to the current status would be discussed in this course. Atmospheric chemistry is mostly an observational science. Some of those concepts would also be introduced in this course.

3. Text Books: "Introduction to Atmospheric Chemistry", Daniel J Jacob, Princeton University Press, Princeton, New Jersey, 1999.

4. Reference Books: RB-1: "Atmospheric Chemistry and Physics: From Air Pollution to Climate Change" John H. Seinfeld and Spyros N. Pandis, John Wiley & Sons, Inc., Hoboken, New Jersey, 2016.

RB-2: "Atmospheric Thermodynamics", Gerald R. North and Tatiana L. Erukhimova, Cambridge University Press, New York, 2009.

5. Learning Outcome of the Course: After completion of the course students are expected to:

- Predict the fate of molecules and radicals in atmosphere.
- Qualitatively explain and quantitatively calculate photolysis rate constant.
- Explain basic principles of greenhouse effect.
- Qualitatively explain production and destruction of ozone.
- Predict degradation pathways of natural and anthropogenic trace gases.

6. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1: Atmospheric parameters	**L1.1:** Mixing ratio, Number density, Partial pressure	**TB-1** 1.1- 1.3	Recognize parameters, such as, composition, temperature, pressure, to describe atmosphere
	L1.2: Measurement: mass of atmosphere, vertical profile of pressure, Barometric law, Sea-Breeze circulation	**TB-1** 2.1– 2.5	
2: Atmospheric models	**L2.1 – L2.2:** One-box model, concept of life time, mass balance equation, Multi-box model, Puff model	**TB-1** 3.1 –3.3	Implement simple models to determine change in atmospheric parameters
	L2.3 – L2.5: Geostrophic flow, general circulation, vertical transport, latent heat release from cloud formation, turbulance	**TB-1** 4.1 –4.4	
	L2.6 – L2.7: Eulerian form and Lagrangian form	**TB-1** 5.1– 5.2 Class discussion	
3: Chemistry in atmosphere	**L3.1 – L3.5:** Geochemical cycling of elements, early evolution of atmosphere, nitrogen cycle, oxygen cycle, carbon cycle	**TB-1** 6.1– 6.5 Class discussion	Comprehensive understanding of chemical processes undergoes in atmosphere
	L3.6 – L3.10: Factors affecting light flux, Quantitative spectroscopy, Rates of photolysis, photodissociation	**RB-1** 4.1–4.10	
	L3.11 – L3.13: Radiation, effective temperature of earth, absorption of radiation by atmosphere, radiative forcing, water vapor and cloud feedback, optical depth	**TB-1** 7.1– 7.6	
	L3.13 – L3.15: Sources and sinks of aerosols, radiative effects: scattering, visibility reduction, perturbation to climate	**TB-1** 8.1– 8.2	
	L16 – L19: Rate expressions for gas-phase reactions, bimolecular reactions, three body reactions, reverse reactions, chemical equilibrium, photolysis, radical assisted reaction chain	**TB-1** 9.1– 9.4	
4: Ozone in atmosphere	**L4.1 – L4.4:** Chapman mechanism, catalytic loss cycles (HO_x, NO_x, ClO_x), Polar ozone loss: mechanism, PSC formation, ozone holes	**TB-1** 10.1–10.4	Mechanism towards formation and destruction of ozone
	L4.5 – L4.7: Hydroxyl radical, global budgets of CO & CH_4, Cycling of HOx and production of ozone, global budget of nitrogen oxides and tropospheric ozone, anthropogenic influence on ozone and OH	**TB-1** 11.1–11.6	

5: Pollution in atmosphere	**L5.1 – L5.3:** Air pollution and ozone, ozone formation and control strategies, ozone production efficiency.	**TB-2** 12.1 – 12.3	Ozone air pollution and acid rain
	L5.4 – L5.5: Chemical composition of precipitation, sources of acids: sulfur chemistry, effects of acid rain, emission trends	**TB-2** 13.1 – 13.4	

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**	**Nature of component (Close Book/ Open Book)**
Mid-Semester Test	90 Min.	30	<TEST_1>	Close book & open book
Comprehensive Examination	120 Min.	40	<TEST_C>	Close book & open book
$ Continuous evaluation	-	30		Close book & open book

7. Chamber Consultation Hour: Will be declared in the class

8. Notices: Will be displayed in Nalanda/Google Class Room

9. Make-up Policy: According to general guideline of the institute.

10. Note (if any): Atmospheric chemistry is an observational science. An effort will be made to present experimental data in the lectures. Advanced topics will be provided for short project in the area of atmospheric chemistry and physics.

Instructor-in-charge
Course No. CHEM F430