

Value Added Course by Prof. Kalyan Bhuyan and Dr Binita Pathak

Course Title: Basic Atmospheric Science

Nature of the Course: Value added

Total Credit assigned: 2

Total Marks: 50

Course Description

This course provides a basic introduction of Earth's atmosphere, including its evolutionary history, composition and structure. Topics covered include the layers of the atmosphere categorized based on temperature and density, hydrostatic equilibrium, and the environmental lapse rate. Additionally, students will delve into the chemistry and thermodynamics of the atmosphere, examining processes like ozone photochemistry, aerosol characteristics, and the energy balance of the Earth-Atmosphere system. Fundamental principles such as gas laws, heat transfer mechanisms, and thermodynamic properties of water will also be studied, providing a comprehensive understanding of the dynamics driving atmospheric processes and their impact on Earth's climate. Further, Earth's upper atmosphere and its interaction with the Sun is also included.

Course Outcome

- Gain an understanding of the Earth's atmosphere.
- Explore the composition of the Earth's atmosphere, its roles in the enhanced greenhouse effect and global warming.
- Investigate the ionosphere, and its interaction with the Sun
- Examine atmospheric chemistry
- Apply the laws of thermodynamics to the Earth's atmosphere

Learning Outcome

- Demonstrate a comprehensive understanding of the Earth's atmosphere
- Evaluate the role of atmospheric composition in the enhanced greenhouse effect and global warming.
- Investigate the ionosphere, exploring its formation principles,
- Examining solar phenomena such as sunspots, solar wind, and coronal mass ejections (CMEs).

- Apply knowledge of atmospheric chemistry to analyze processes like ozone photochemistry, and ozone hole
- Apply the knowledge of thermodynamics to understand fundamental thermodynamic processes in the atmosphere and the properties of water.
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Course Content

Unit I. Introduction to Earth's Atmosphere

Evolution of the Earth Atmosphere, Hydrostatic Equilibrium, Extent of the Atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere, Environmental lapse rate
 State of the earth's atmosphere: main constituents of dry air, CO₂, Ozone, water vapour, aerosols, enhanced greenhouse effect, direct and indirect effects of aerosols, global warming
 Ionosphere: principle of formation, Chapman's hypothesis, ionization by energetic particles, D, E, and F layers,
 Structure of the Sun, sunspots, solar wind, CMEs

Unit II. Atmospheric Chemistry and Thermodynamics

Chemistry of the Troposphere and Stratosphere: Ozone photochemistry, Chapman cycle, O₃ photolysis, altitude, latitude, diurnal and seasonal variation of ozone, HO_x, NO_x, ClO_x cycles, Tropospheric ozone, ozone hole

Aerosols: optical and physical properties, chemical composition, size distribution, vertical distribution, absorption and scattering of solar radiation by gases and aerosols, Scattering of solar radiation: Rayleigh and Mie scattering, Energy balance of the Earth-Atmosphere system, radiative forcing

Gas laws, ideal gas law, moist air, mean molecular weight of dry and moist air, heat transfer in the atmosphere, warming and cooling of the Earth and its atmosphere, first law of thermodynamics and potential temperature, Poisson relation, thermodynamic properties of water, latent heat, Clausius Clapeyron's relation

Suggested Readings:

1. The Atmosphere: An Introduction to Meteorology, Frederick K. Lutgens, Edward J. Tarbuck, PHI Learning

2. Atmospheric Chemistry and Physics, J H Seinfeld and S N Pandis, John Wiley and Sons
- Introduction to Atmospheric Physics, D G Andrews, Cambridge University Press
3. Fundamentals of Atmospheric Modelling, M Z Jacobson, Cambridge University Press
4. An Introduction to Atmospheric Radiation, K N Liou, Academic Press
5. Basics of Atmospheric Science, A Chandrasekar, PHI Learning

6. Stratosphere Troposphere Interactions: An Introduction, K Mohankumar, Springer
7. The Solar Terrestrial Environment, J K Hargreaves, Cambridge University Press
8. Space Plasma Physics, A C Das, Narosa Publishing House