Approved in 29th Senate

IIT Mandi

Course Number	: CE 558
Course Name	: Air pollution and its mitigation
Credits	: 3-0-0-3
Prerequisites	: IC 230 (Environmental Science) for B.Tech.
Intended for	: 3rd and 4th year B.Tech., Post-graduate
Distribution	: Elective

1. Preamble:

The atmospheric system mediates phenomena ranging from local- and regional-scale air pollution to global-scale climate change, thereby affecting the environment, human health and the sustainability of the planet as a whole. A robust understanding of these processes and the complexities of the earth-atmosphere-climate system is critical to the ability to design effective mitigation technologies and policies. This course aims to foster this understanding by focusing on the fundamental physical and chemical processes that govern atmospheric behaviour, especially related to the residence, transformation, transport, and deposition of gaseous and aerosol species. This is followed by analyses of the natural and anthropogenic controls on various aspects of air pollution, and perspectives on their measurement, monitoring, risk assessment and mitigation.

Learning outcomes: The students would i) develop a thorough understanding of the interactive processes that lead to atmospheric pollution on varying spatial scales; ii) appreciate the links between air quality and health; iii) develop insights into the theoretical and practical aspects of air pollution control engineering; and v) draw lessons from the success stories and failures of local, regional and global policies to tackle air pollution.

2. Course Modules:

Module 1: The atmospheric system **[5 Hours]**

Vertical profiles of pressure and temperature; atmospheric structure; hydrostatic equilibrium and scale height; stability and lapse rates; temperature inversions; atmospheric dispersion; general circulation and surface winds; timescales of atmospheric transport

Module 2: Basics of atmospheric chemistry **[2 Hours]**

Photochemical and radical-assisted reactions; daytime vs nighttime and tropical vs polar chemistry; species lifetimes; atmospheric measurement units

Module 3: Stratospheric processes **[5 Hours]**

Dynamics of stratospheric transport; formation and distribution (latitudinal, seasonal and vertical) of stratospheric O_3; UV shielding and effect on climate; role of HO_x, NO_x and chlorofluorocarbons in catalyzing O_3 depletion – observational evidence, mitigation measures, recovery and challenges

Module 4: Tropospheric gas-phase species **[8 Hours]**

Local, regional and global pollutants; the oxidizing capacity of the troposphere; constraints on CO and CH_4; the CO-HO_x-NO_x-VOC-O_3 cycle; photochemical smog – case study of Los Angeles, USA; dry and wet removal of pollutants; acidic deposition – case study of the Northeastern USA; current scenario in Asia and the Indian perspective; mitigation, challenges and opportunities

Module 5: Aerosols **[6 Hours]**

Historical perspectives on air pollution; physical properties of aerosols – formation, growth, aging and size distribution; primary vs secondary and externally- vs internally-mixed aerosol; core-shell theory; major aerosol chemical components and their sources; tracers

Module 6: Air pollution control technologies **[11 Hours]**

Basics of air pollution control system design – velocities, flow rate, pressure drop, nature of combustion, acid dew point, particle settling and drag forces, diffusion; mitigation technologies in stationary systems – fluidized bed combustion, integrated gasification combined cycle, flue gas desulfurization, baghouses, scrubbers, cyclone collectors, and electrostatic precipitators; mitigation technologies in mobile systems – crankcase, evaporative and tailpipe emissions from automobiles, catalytic converters, diesel particulate filters, fuel modification and blending

Module 7: Risk assessment and policy intervention on air pollution **[5 Hours]**

Link between air pollution and mortality/morbidity; risk assessment for carcinogenic and non-carcinogenic pollutants; air quality indices – case study of India; air pollution as an externality; ambient, emission and technology standards; policies for air pollution control

3. **Textbooks:**
   i) Atmospheric Chemistry and Physics: From Air Pollution to Climate Change; 3rd Edition, 2016; John H. Seinfeld and Spyros N. Pandis; Wiley.
   ii) Introduction to Atmospheric Chemistry; 1st Edition, 2000; Daniel J. Jacob; Princeton University Press.
   iii) Air Pollution Control Engineering, 2nd Edition, 2000; Noel De Nevers; McGraw-Hill.

4. **References:**
   i) Chemistry of the Upper and Lower Atmosphere; 2nd Edition, 2000; Barbara J. Finlayson-Pitts and James N. Pitts Jr; Academic Press.
   ii) Environmental Chemistry, 5th Edition, 2012; C. Bard and M. Cann; W.H. Freeman and Company.
   iii) Research articles will be advised as required.

5. **Similarity Content Declaration with Existing Courses**

S.N.	Course Code	Similarity Content	Approx. % of Content
1	IC 230 (Environmental Science)	Introduction to air pollution (minor)	5%

6. **Justification for new course proposal if cumulative similarity content is > 30%:** N.A.

Approvals: