**ONLINE SELF-PACED SELF-LEARNING COURSE**

# ES 250 ENVIRONMENTAL STUDIES

**SPRING SEMESTER 2024-2025**

**Content Delivery Mode:** This is an online, self-paced, self-learning course. The lectures and study materials will be available at https://moodle.iitb.ac.in/login/index.php

**Faculty Coordinators*:** Professor Swatantra Pratap Singh (Course Coordinator): swatantra@iitb.ac.in
Professor Srinidhi Balasubramanian (Course Coordinator): srinidhi@iitb.ac.in

**Grading:** This is a PP/NP course.
***Final Exam will be conducted during Mid-Semester Week as per Institute calendar.***
Details of grading and exam format will be announced on a closer date.

**Learning Outcomes:**

(1) To understand the multi-disciplinary nature of environmental studies
(2) To get familiar with natural resources such as forests, water, minerals, energy, land
(3) To learn the concept of sustainable development, ecosystems, biodiversity and its conservation design approach of criteria air pollutant controls
(4) To understand environmental pollution: air, water, soil, solid and hazardous waste management and treatment and the relationship between environment and human health and relevant environmental legislation.
(5) To learn about global environmental issues: climate change, global warming, acid rain, ozone layer depletion

**Topics to be covered:**

| Topic | Number of videos | Approximate Duration (minutes) | Approximate Weightage for Final Exam (%) |
|---|---|---|---|
| Water & Wastewater Pollution | 5 | 250 | 33 |
| Air Pollution | 13 | 150 | 23 |
| Environmental Management Systems | 1 | 50 | 6 |
| Global Environmental Change | 3 | 160 | 20 |
| Solid and Hazardous Waste Management | 5 | 100 | 12 |
| Environmental Legislations | 3 | 50 | 6 |
| **Total** | | **760 minutes** | **100 %** |

**Suggested Textbooks and References:**


(1) Cunningham W.P. and Cunningham M.A., Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi, 2002.

(2) Dasgupta, P. and Maler, G. (eds.), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi, 1997.

(3) Jackson, A.R.W. and Jackson, J.M. Environmental Sciences: The Environment and Human Impact, Longman Publishers, 1996.

(4) Nathanson, J.A., Basic Environmental Technology, Prentice Hall of India, New Delhi, 2002.

(5) Redclift, M. and Woodgate, G. (eds.), International Handbook of Environmental Sociology, Edward Edgar, 1997.

(6) Srivastava, K.P., An Introduction to Environmental Study, Kalyani Publishers, Ludhiana, 2002

(7) Arceivala, Soli J, and Shyam R. Asolekar. 2007. Wastewater Treatment for Pollution Control and Reuse. 3rd ed. McGraw Hill Education (India) Private Limited.

(8) Masters, G.M., and Ela, W.P., Introduction to Environmental Engineering, 3rd Edition, Pearson New International Edition, 2013.

(9) Seinfeld, J. H. and Pandis, S N., Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John Wiley, New York, 2016.

(10) de Nevers, N., Air Pollution Control Engineering, McGraw Hill, New Delhi, 1995.

(11) Hinds, W.C., Aerosol Technology: Principles, Behavior and Measurements of Airborne Particles, Wiley: NY, 1999.

(12) Kulkarni, V., Ramachandra, T.V. 2006. Environmental Management. Capital Publishing Company, New Delhi.


***Some lecture-specific reference materials may be found in Appendix A for additional learning.***

**Prerequisite:** None

**Remarks:**

1. Please make sure that you have **access to MOODLE**. This is the central location for lecture videos, slides, notes, information exchange and announcements for the class.

2. The lecture videos and notes will be uploaded in the beginning of the semester, and as a student of this course, you are expected to take this course as a self-learning exercise. The sequence of each lecture along with the topics covered and learning objectives is provided as Appendix A.

3. The Final Exam will be comprehensive and scheduled during the Mid-Semester Exam week of the Spring 2023-24 semester.

| APPENDIX A<br>WATER AND WASTEWATER POLLUTION MODULE | | | | |
|---|---|---|---|---|
| **Lecture Sequence** | **Video Title** | **Duration** | **What you will be able to answer** | **Resources** |
| **Water-01** | Water availability, composition, water pollution and water quality parameters | 1:21:37 | 1. Natural water availability and composition<br>2. Water pollution<br>3. Water quality parameters | |
| **Water-02** | Sewage treatment and sludge disposal | 46:10 | 1. Basic municipal wastewater treatment train<br>2. Sludge management | |
| **Water-03** | Water treatment process | 44:16 | 1. Conventional drinking water treatment process<br>2. Coagulation-flocculation<br>3. Particulate settling<br>4. Sand filtration<br>5. Disinfection | |
| **Water-04** | Advanced water treatment processes | 43:23 | 1. Advanced oxidation processes<br>2. Membrane purification systems<br>3. Algal treatment systems<br>4. Emerging contaminants | |
| **Water-05** | Resource recovery & decentralized treatment | 46:04 | 1. Linear & circular economy<br>2. Resource recovery<br>3. Decentralized water treatment | |

| AIR POLLUTION MODULE | | | | |
|---|---|---|---|---|
| **Lecture Sequence** | **Video Title** | **Duration** | **What you will be able to answer** | **Additional Resources** |
| **Air-01** | Framework for Air Quality Management | 15:05 | 1. What are the three key steps in air quality management? | |
| **Air-02** | Overview of Air Pollution | 27:06 | 1. How would one know if the air is polluted ?<br>2. What is clean air ?<br>3. What is the scale of earth's atmosphere wrt an apple ?<br>4. What are Air pollution standards?<br>5. Why is volume required for the estimate of exposure ? | https://cpcb.nic.in/uploads/National_Ambient_Air_Quality_Standards.pdf<br><br>https://cpcb.nic.in/upload/NAAQS_2019.pdf |
| **Air-03** | Basics of air pollution sources, types | 10:09 | 1. What are the sources of air pollution ?<br>2. Classification of pollution from sources<br>3. What is an example of an area source? | |
| **Air-04** | Meteorology (Part 1 of 3) | 07:40 | 1. Can you draw a schematic of a dispersion plume model?<br>2. Can you explain the three key features of a wind rose ? | Gaussian Plume Model Details : https://apsi.tech/material/modeling/IntroductiontoGaussianPlumeModels.pdf<br>Wind Rose : https://www.youtube.com/watch?v=ovAH-8-4K5I<br>https://www.wikihow.com/Read-a-Wind-Rose |
| **Air-05** | Meteorology (Part 2 of 3) | 13:18 | 1. What is the benefit of vertical mixing ?<br>2. What are adiabatic and environmental lapse rates ?<br>3. Can you explain stability ? | Please see on YouTube : Many videos are available |

| AIR POLLUTION MODULE | | | | |
|---|---|---|---|---|
| **Air-06** | Meteorology (Part 2 of 3) | 12:07 | 1. As a decision maker, why are we doing all this work with meteorology ?<br>2. Why are good data important (for example wind rose in Chandrapur)? | |
| **Air-07** | Nature of Air Pollutants | 16:51 | 1. What are the key features of the National ambient air quality standards (NAAQS)?<br>2. What is the difference in the nature of air pollutants (gases, particles) ?<br>3. What is the rationale for using criteria pollutants?<br>4. What is the difference between Primary and secondary pollutants?<br>5. How would you estimate total particle concentration?<br>6. Can you explain the scales of pollutants (Ants and Elephants)?<br>7. Where else can aerosol science and engineering be useful ? | https://www.youtube.com/watch?v=e6rglsLy1Ys |
| **Air-08** | Types of particles and size distributions of particle in ambient air | 18:31 | 1. What is the significance of particle sizes and their characteristics : Give 2 examples.<br>2.What are the three modes of atmospheric particle size distributions ?<br>3. One 1 micrometer particle mass = Mass of 1000 particles of 0.1 micrometer : Why ?<br>4. What are the mechanisms that remove particles of different sizes from the atmosphere? | https://www.youtube.com/watch?v=YsFuJONjLZk |

| AIR POLLUTION MODULE | | | | |
|---|---|---|---|---|
| | | | 5. What is alveolar deposition?<br>6. Why is the PM2.5 to PM10 ratio important? | |
| **Air-09** | Sizing of particles Part (1 of 2) | 09:27 | 1. Why is sieving not possible for particles smaller than 10µm?<br>2. How are particles separated by inertial impaction in a jet-plate configuration?<br>3. How are particles sized and counted by optical detection? | General : (MSP) https://www.youtube.com/watch?v=VcEgEkLR3Fk<br>Impactor: https://www.youtube.com/watch?v=zYMSEaga19M<br>OPC: https://www.youtube.com/watch?v=z3_tM4OPlqI |
| **Air-10** | Sizing of particles Part (2 of 2) | 08:23 | 1. How is electrical mobility used to size particles?<br>2. How does condensation of a vapour onto a particle help in a CPC ?<br>3. List some field measuring instruments for particulate matter. | https://www.youtube.com/watch?v=6yqdKTdIyJI<br>https://www.youtube.com/watch?v=Msu-9YgvjCs |
| **Air-11** | Control of Particulate Pollutants in the Industry (Part 1 of 2) | 04:33 | 1. For what size of particles can gravitational settling be utilised ?<br>2. What is the principle of a "Cyclone Separator"? | Gravitational settler: https://www.slideshare.net/joyjones71697/gravity-settling-chambers-for-controlling-air-pollution<br><br>Cyclone separator: https://www.slideshare.net/vicky937/cyclone-separator-32095112<br><br>https://www.youtube.com/watch?v=ztJOdPkJTuU |
| **Air-12** | Control of Particulate | 07:10 | 1. What are the three key mechanisms of particle removal in fabric filtration? | Fabric filter |

| AIR POLLUTION MODULE | | | | |
|---|---|---|---|---|
| | Pollutants in the Industry (Part 2 of 2) | | 2. How is electrical mobility used to remove particles from gas stream, for example, in a coal power plant? | https://www.youtube.com/watch?v=IY8srI8zTfw<br><br>https://www.youtube.com/watch?v=2zUChlWGrbY<br><br>ESP:<br>https://byjus.com/physics/electrostatic-precipitator/<br>https://www.youtube.com/watch?v=PUNuY8c5m2Y |
| **Air-13** | Control of Gaseous Pollutants in the Industry | 05:18 | 1. What are three key principles of gaseous emissions control in the industry? | Absorption, Adsorption, Incineration :<br>https://www.britannica.com/technology/airpollutioncontrol/Control-of-gases<br><br>Absorption:<br>https://www.youtube.com/watch?v=SmfxGVbcpSA<br><br>Adsorption:<br>https://www.youtube.com/watch?v=zWq68y_tjTE&t=419s<br><br>Incineration:<br>https://www.youtube.com/watch?v=t6Qeg-fq5dg |

| ENVIRONMENTAL MANAGEMENT SYSTEMS MODULE | | | | |
|---|---|---|---|---|
| **Lecture Sequence** | **Video Title** | **Duration** | **What you will be able to answer** | **Resources** |
| **EMS-01** | Environmental Management System | 47:30 | 1. Definition and goal of EMS<br>2. PDCA model<br>3. Need & basic principles of ISO 14000 standards<br>4. Elements of EMS as per ISO 14001 standard | |

| GLOBAL ENVIRONMENTAL CHANGE MODULE | | | | |
|---|---|---|---|---|
| **Lecture Sequence** | **Video Title** | **Duration** | **What you will be able to answer** | **Resources** |
| **Global environmental change-01** | Planetary Boundaries and climate change | 89:00 | 1. Concept of environmental change and planetary boundaries<br>2. Definition, drivers and mitigation options to meet nine key planetary boundaries<br>3. Difference between weather and climate<br>4. Concept of global warming, climate forcing and climate feedback<br>5. Pollutants, sources and processes that contribute to global climate change | 1. IPCC Fifth Assessment Report: https://www.ipcc.ch/assessment-report/ar5/<br>2. Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., De Vries, W., De Wit, C.A. and Folke, C., 2015. Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223), p.1259855. |

| | | | | |
|---|---|---|---|---|
| **Global environmental change-02** | Natural Resources | 45:00 | 1. Basic concepts and problems associated with natural resources<br>2. Classification of natural resources | 1. Unit 2 of the "Textbook for Environmental Studies", Erach Bharucha, UGC, 2004.<br>2. International Resource Panel (https://www.resourcepanel.org/) |
| **Global environmental change-03** | Ozone layer depletion | 24:00 | 1. Concept of ozone layer<br>2. Measurement of ozone layer<br>3. Mechanism of ozone depletion<br>4. Mitigation strategies | |

| SOLID AND HAZARDOUS WASTE MANAGEMENT MODULE | | | | |
|---|---|---|---|---|
| **Lecture Sequence** | **Video Title** | **Duration** | **What you will be able to answer** | **Resources** |
| **Waste - 01** | Municipal solid waste management - Waste definition, SWM Rules (2016), Waste sampling and characterisation, Waste collection and transfer systems | 63:28 | 1. Integrated solid waste management,<br>2. Functional elements of a waste management system,<br>3. Typical waste characteristics and disposal methods,<br>4. Waste hierarchy<br>5. Duties of waste generators<br>6. Waste sampling and characteristics- physical properties, proximate analysis, elemental composition<br>7. Difference between Centralized and Decentralized waste treatment<br>8. Transfer stations - Need and type of systems<br>9. Types of collection systems and services<br>10. Waste transfer methods - Hauled and stationary container systems | |
| **Waste-02** | Separation, processing and transformation of municipal solid waste | 22:00 | 1. Functional elements of a solid waste management system<br>2. Physical, Chemical and Biological Methods for municipal solid waste treatment<br>3. Unit Operation Used for the Separation and Processing of Waste Materials<br>4. Material Recovery Facility (MRF) | |
| **Waste-03** | Biological processes for municipal solid waste treatment | 17:00 | 1. Composting<br>2. Anaerobic Digestion<br>3. Circular Economy in MSW Management | |
| **Waste-04** | Waste to Energy Systems | 15:00 | 1. Concept of waste to energy<br>2. Incineration<br>3. Emissions from incineration<br>4. Gasification | |
| **Waste-05** | Sanitary Landfills | 17:00 | 1. What is Sanitary Landfill<br>2. Components of Sanitary Landfills<br>3. Post-closure care of Landfill<br>4. Mechanical Biological Treatment | |

| ENVIRONMENTAL LEGISLATIONS MODULE | | | | |
|---|---|---|---|---|
| **Lecture Sequence** | **Video Title** | **Duration** | **What you will be able to answer** | **Resources** |
| **Environmental legislations-01** | What is India's "Environmental Framework"? | 24:15 | 1. What are the principal components of the Indian legal conceptualization of "Environment"?<br>2. With the help of an example, explain the significance of the concept of "Systemic view of the environment"? | |
| **Environmental legislations-02** | What are the significant elements of India's "Water Act" and "Air Act"? | 10:50 | 1. What is the aim of the "Water Act"?<br>2. What is the aim of the "Air Act"?<br>3. What are the chief differences between the "Water Act" and "Air Act"? | |
| **Environmental legislations-03** | What are the forthcoming environmental challenges in India? | 20:48 | 1. What are the forthcoming challenges related to municipal pollution in Indian cities?<br>2. What are the forthcoming challenges related to municipal pollution in Indian rural areas? | |