



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Environmental Engineering

Subject Code: BE05013031

Subject Name: Fundamentals of Air Pollution

|                         |                          |
|-------------------------|--------------------------|
| w. e. f. Academic Year: | 2024-25                  |
| Semester:               | 5                        |
| Category of the Course: | Professional Core Course |

|                      |                                                                                                                           |
|----------------------|---------------------------------------------------------------------------------------------------------------------------|
| <b>Prerequisite:</b> | Basic Knowledge of Environmental Science and Sustainability                                                               |
| <b>Rationale:</b>    | To learn the principles and theories behind indoor and outdoor air pollution due to emission of different air pollutants. |

## Course Outcomes:

| Sr. No. | CO statement                                                                                                                                                      | Marks% weightage |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| CO-1    | Relate indoor and outdoor sources and types of air pollutants and their effects on environment.                                                                   | 11               |
| CO-2    | Explain effects of meteorological condition on categorization of atmospheric stability and calculate air pollution concentration                                  | 22               |
| CO-3    | Demonstrate stack and ambient air quality monitoring.                                                                                                             | 33               |
| CO-4    | Summarize sources, effects and control of noise and odour pollution                                                                                               | 16               |
| CO-5    | Apply appropriate monitoring and analytical techniques to assess indoor air quality parameters and understand atmospheric photochemical pollutant concentrations. | 18               |

## Teaching and Examination Scheme:

| Teaching / Learning Scheme<br>(in Hours per semester) |   |    |    |                                | Total Credits | Assessment Pattern and Marks |             |                      |           |         | Total Marks |
|-------------------------------------------------------|---|----|----|--------------------------------|---------------|------------------------------|-------------|----------------------|-----------|---------|-------------|
| L                                                     | T | P  | SL | Total no of hours per semester |               | Theory                       |             | Tutorial / Practical |           |         |             |
|                                                       |   |    |    |                                |               | ESE (E)                      | PA / CA (M) | PA/CA (I)            | TW/SL (I) | ESE (V) |             |
| 45                                                    | 0 | 30 | 15 | 90                             | 3             | 70                           | 30          | 20                   | 30        | 50      | 200         |

## Contents:

| Sr. No. | Content                                                                                                | Total Hrs |
|---------|--------------------------------------------------------------------------------------------------------|-----------|
| 1       | <b>Introduction:</b><br>Indoor and outdoor air pollution: Sources, types and effects of air pollutants | 05        |



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|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 2            | <b>Meteorology:</b><br>Introduction, Atmosphere and its structure with 3D atmospheric profile visualization tools, solar radiation, wind circulation, lapse rates, stability conditions, wind velocity profile, maximum mixing depth, Conventional and modern tools wind rose diagram, turbulence, general characteristics of stack plumes, heat island effect<br><b>Dispersion of Pollutants in the Atmosphere:</b><br>Introduction to Gaussian dispersion model, model terms, assumptions and applications, concept of plume rise and calculation of effective stack height                                           | 10        |
| 3            | <b>Air Quality Monitoring and Standards:</b><br>Objectives of Air quality Monitoring, Types of Air Quality monitoring, Stack Standards, National Ambient Air Quality standards,<br><b>Stack Monitoring:</b><br>Purpose, Planning, Specification of Equipment, Steps of Testing, Sampling Procedure, Steps to be followed during Stack, Emission Factors for source strength<br><b>Ambient Air Monitoring:</b><br>National Ambient Air Quality Monitoring Program, Guidelines for sampling and analysis of Air pollutants<br><b>Air Quality Index:</b> Concept, calculation methodology, interpretation and applications | 15        |
| 4            | <b>Noise Pollution and odour pollution:</b><br><b>Noise Pollution:</b><br>Sound and Noise, Characteristics of sound, Noise Pollution, Noise Measurement Scale – Levels and the decibels, Sources of Noise, Effects of Noise on people, Indian Standards, Noise pollution control strategies<br><b>Odour Pollution:</b><br>Introduction, Effects of odour, sources of odour, measurement of odour, odour control technologies                                                                                                                                                                                            | 7         |
| 5            | <b>Indoor Air Pollution:</b><br>Factors Affecting on Indoor Air Quality, Indoor Aerosols, Monitoring and Analysis, Indoor Air Purification Technologies: Air purifiers, HEPA filters, Activated Carbon filters, Electrostatic precipitators, Ionizers                                                                                                                                                                                                                                                                                                                                                                   | 4         |
| 6            | <b>Atmospheric Photochemical reactions:</b><br>Introduction, Role of oxides of nitrogen in photo oxidation, hydro carbon in atmospheric photo chemistry, oxidants in photo chemical smog                                                                                                                                                                                                                                                                                                                                                                                                                                | 4         |
| <b>TOTAL</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>45</b> |

Suggested Specification table with Marks (Theory): (For B.E. only)

| Distribution of Theory Marks |         |         |         |         |         |
|------------------------------|---------|---------|---------|---------|---------|
| R Level                      | U Level | A Level | N Level | E Level | C Level |
| 10                           | 40      | 30      | 10      | 10      |         |



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**R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**The syllabus of Fundamentals of Air Pollution achieves following SDGs Goals**

|        |                                         |
|--------|-----------------------------------------|
| SDG 3  | Good Health and Well-being              |
| SDG 9  | Industry, Innovation and Infrastructure |
| SDG 11 | Sustainable Cities and Communities      |
| SGD 13 | Climate Action                          |

## Reference Books:

1. Air Pollution – by Wark & Warner
2. Air Pollution – by M. N. Rao
3. Air Pollution – by Henry Parkins
4. Air Pollution – by Stern Vol – I
5. Air Pollution Control and Analysis- by J.R. Mudakavi
6. Handbook of Methods in Environmental Studies Vol-2 Air, Soil, Noise and Overburden Analysis

## List of Experiments:

1. Measurement of Ambient Air Quality Parameters using PM<sub>10</sub> and PM<sub>2.5</sub> Sampler (Demo/Virtual).
2. Measurement of Sound Pressure Levels at different locations (Demo/Virtual).
3. Measurement of different air pollutants from Indoor Environment (Demo/Virtual).
4. Stack Monitoring Kit (Demo/Virtual).
5. Measurement of Wind Velocity using Anemometer (Demo/Virtual).

## Major Equipment:

1. PM<sub>10</sub> and PM<sub>2.5</sub> sampler.
2. Stack monitoring kit
3. Sound Meter
4. Indoor Sensor based Automatic Analyzers
5. Anemometer

## List of Open-Source Software/learning website:

1. US-EPA: <https://2ch438ss.wordpress.com/wp-content/uploads/2013/12/plume-behavior-part-i.pdf>
2. Swayam NPTEL-MOOC Course on Air pollution and control



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3. Swayam NPTEL-MOOC Course on Indoor Air Pollution
4. Central Pollution Control Board sampling and analysis Guidelines

## List of suggested activities for Term Work / Self Learning:

### PART [A]: ASSIGNMENT:

1. Air Pollution: Sources and effects on human, vegetation, animals, and materials
2. Numericals on Expression of gaseous pollutants.
3. Assignments and numerical based on meteorology.
4. Assignments and numerical based on dispersion of Pollutants in the atmosphere.
5. Assignments and numerical based on Noise Pollution
6. Assignments based on odour and control
7. Assignment based on Indoor Pollution.
8. Assignments based on photochemical atmospheric reactions.

### PART [B] Self-Learning Activities:

| Sr. No. | PBL Category             | Name of the Activity                                                                                                                                                                             | No. of Hours      | Evaluation Criteria                                                            |
|---------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------------------------------------------|
| 1       | Mini Project             | Low-Cost Air Quality Indicator Model, indoor air quality checklist tool, pollution exposure risk calculator, AQI Mapping of Campus/City Area, Comparative Study of Air Purification Technologies | Duration = 10 hrs | Based on Concept, Innovation, Technical contents, Documentation, Demonstration |
| 2       | Micro project            | Indoor CO <sub>2</sub> ventilation efficiency study/ Campus Noise Measurement Study/ Classroom indoor air Quality/ Air purifier efficiency test/ indoor particulate source identification/       | Duration = 5 hrs  | Based on Concept clarity, Report and presentation preparation                  |
| 3       | Seminar                  | Seminar based on given technical topics beyond syllabus                                                                                                                                          | Duration= 10 hrs  | Based on Technical Contents and Presentation                                   |
| 4       | Concept Mapping Activity | Prepare a detailed concept map covering: Indoor vs Outdoor air pollution Sources and types of pollutants Effects on humans, vegetation, materials Indoor air quality factors                     | Duration= 4 hrs.  | Based on Logical connections, technical accuracy, Visual clarity, References   |



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|    |                                                  |                                                                                                                                                                                                         |                  |                                                                                                                      |
|----|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------------|
| 5  | Air Pollution Calculations Manual                | Conversion of gaseous pollutants (ppm ↔ mg/m <sup>3</sup> ), Wind velocity profile, Effective stack height, Effective stack height, Maximum Mixing Depth, Effective stack height                        | Duration= 8 hrs  | Based on Correct formula selection, Calculation accuracy, Interpretation of results                                  |
| 6  | Field Observation Study                          | Ambient Air Quality Survey: identify 3 locations: traffic zone, residential zone, industrial zone and record visible sources, possible pollutants, meteorological conditions and compare with the NAAQS | Durations= 6 hrs | Based on analytical comparison, Understanding of standards, Observation quality, Mini Report                         |
| 7  | Mini Project (Meteorology Data Analysis Project) | Wind Rose Study Collect weekly wind data from IMD website and plot Wind Rose diagram with the help of Software and predict pollution dispersion behavior                                                | Duration = 8 hrs | Based on Data interpretation, Linkage with dispersion, Graphical clarity, Short analytical report with graph.        |
| 8  | Mini Project (Noise Monitoring Mini Survey)      | Noise measurement: Measure sound levels or use mobile-based sound meter app at different locations and Compare readings with Indian noise standards                                                     | Duration= 5hrs   | Based on Measurement procedure, Comparison accuracy, Suggested control measures                                      |
| 9  | Video Based Learning                             | NPTEL Videos based learning on given topics                                                                                                                                                             | Duration = 5 hrs | Based on MCQ test                                                                                                    |
| 10 | Poster / PPT Development                         | Poster Regarding stack gas, ambient air, noise and odour sampling                                                                                                                                       | Duration = 4 hrs | Based on Technical content, Visual communication, Presentation clarity, Scientific Poster, 10-slide PPT Presentation |

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