**Indoor air pollution control**

**Fall semester, 2019-2020**

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| Coordinator | **Nghiem Trung Dung** |
| Credits | 3 ECTS (optional course), 45 in-class hours |
| Lecturers | **Nghiem Trung Dung** (Hanoi University of Science and Technology, Vietnam) |
| Level | Ph.D |
| Host institution | **Hanoi University of Science and Technology**, School of Environmental Science and Technology |
| Course duration | October 22 – November 26, 2019 |

### Summary

*This 3 ECTS course serves as an advance to indoor air pollution. It provides doctoral students with advanced knowledge on indoor air pollution control so they can meet the increasing requirements in the fields of environmental engineering as well as natural resources and* *environmental management. The main content of the course includes the sources of indoor air pollutants and their health effects, the evaluation of indoor air quality; health risk assessment; different tools for the control of indoor air pollution.*

*Through the course, students will also be enhanced with analytical, synthesis, presentation and teamwork skills.*

### Target student audiences

Doctoral students in the fields of:

* Environmental engineering
* Environmental science
* Natural resources and environmental management
* Refrigeration engineering

### Prerequisites

Required courses (or equivalents):

* Environmental engineering and/or science
* Natural resources and environmental management

### Aims and objectives

The main course objective is to provide students with advanced knowledge on indoor air pollution, its health effects, evaluation of indoor air quality (IAQ), health risk assessment and methods for the control of indoor air pollution. Characteristics of indoor environments are provided. Sources of indoor air pollutants and their health effects are addressed. Common syndromes when exposed to indoor air pollution. Relationship between indoor and outdoor air quality is mentioned.

To evaluate IAQ. The dynamic characteristics of IAQ are introduced. Collection of general data of IAQ and analysis are presented. Monitoring methodology is introduced. Active and passive sampling methods for IAQ are provided. Difficulties in conducting a sampling programme of IAQ versus outdoor air quality are also given. Methods for source identification are presented. Methods for health risk assessment are also provided.

To control indoor air pollution. Different tools for including the control through design, operation and maintenance; source control; ventilation; air cleaning; institutional measures; education are analyzed and focused.

### General learning outcomes:

Upon completion of the course, PhD students are to:

* be aware of sources of indoor air pollutants.
* understand the health effects of indoor air pollutants
* understand the relationship between indoor and outdoor air quality
* be aware of collecting general data of IAQ and analysis
* be aware of monitoring methodology for IAQ
* be able to conduct a sampling programme for IAQ
* be aware of health risk assessment
* be aware of the control of indoor air pollution through design, operation and maintenance
* be aware of source control of indoor air pollution
* be aware of ventilation for improving IAQ
* be aware of air cleaning in the control of indoor air pollution
* be aware of institutional and educational tools in the control of indoor air pollution

### Overview of sessions and teaching methods

The course will try to make use of interactive and self-reflective methods of teaching and learning including video show, video conference (if possible), course assignment/project and their presentations and discussions. It will start with an introduction to IAQ including sources of indoor air pollutants and their health effects, common syndromes when exposed to indoor air pollution, relationship between indoor and outdoor air quality. Methods for the evaluation of IAQ focusing on monitoring ones are presented. Sampling techniques including active and passive sampling ones are addressed. Health risk assessment is also introduced. Different methods for the control of indoor air pollution including the control through design, operation and maintenance; source control; ventilation; air cleaning; institutional measures; education are emphasized.

### Course workload

The table below summarizes course workload distribution:

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| --- | --- | --- | --- |
| **Activities** | **Learning outcomes** | **Assessment** | **Estimated workload (hours)** |
| **In-class activities** | | | |
| Lectures | Understanding theories, concepts, methodology. | Class participation | 35 |
| Moderated in-class discussions | Understanding indoor air pollution, various methods/techniques for the assessment of IAQ, different methods/techniques for the control of indoor air pollution. | Class participation and preparedness for discussions | 5 |
| In-class assignments | Understanding indoor air pollution, various methods/techniques for the assessment of IAQ, different methods/techniques for the control of indoor air pollution. | Class participation and preparedness for assignments | 5 |
| **Independent work** | | | |
| Group work:   * Contribution to the group case-study projects * Contribution to the preparation and delivery of individual presentation | Ability to use the methods and tools for the assessment of IAQ and for the control of indoor air pollution. | Quality of group assignments and individual presentations | 45 |
| Course group assignment | Ability to deal with real cases of indoor air pollution | Quality of developed measures for the control of the cases and their presentation | 45 |
| ***Total*** |  |  | ***135*** |

### Grading

The students’ performance will be based on the following:

* Process assessment: 40% including:
  + Level of preparedness for participation in class discussions and seminars (10 %) (from 100 % for active participation and demonstrated familiarity with the course readings to 0 % for completely ignoring in-class discussions);
  + Group assignments (15 %) (from 100% for clearly demonstrated input to 0 % for non-participation);
  + Mid-term exam (15%)
* Final exam: 60%

### Course schedule

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| --- | --- | --- | --- |
| **Day**  **(Tentative)** | **Time** | **Topic** | **Lecturer** |
| October 22, Tuesday | 08:00-09:30 | Concept of IAQ. Characteristics of indoor environments | Nghiem Trung Dung |
| 09:45-11:15 | Common syndromes when exposed to indoor air pollution | Nghiem Trung Dung |
| 11:30-12:15 | Relationship between indoor and outdoor air quality | Nghiem Trung Dung |
| October 29, Tuesday | 08:00-09:30 | Sources of indoor air pollutants and their health effects | Nghiem Trung Dung |
| 09:45-11:15 | Sources of indoor air pollutants and their health effects (Continued). | Nghiem Trung Dung |
| 11:30-12:15 | Dynamic characteristics of IAQ | Nghiem Trung Dung |
| November 5, Tuesday | 08:00-09:30 | Collection of general data of IAQ and analysis | Nghiem Trung Dung |
| 09:45-11:15 | Overview on monitoring methodology for IAQ | Nghiem Trung Dung |
| 11:30-12:15 | Active sampling methods for IAQ. | Nghiem Trung Dung |
| November 12, Tuesday | 08:00-09:30 | Passive sampling method for IAQ. | Nghiem Trung Dung |
| 09:45-11:15 | Methods for source identification | Nghiem Trung Dung |
| 11:30-12:15 | Health risk assessment | Nghiem Trung Dung |
| November 19, Tuesday | 08:00-09:30 | Control of indoor air pollution through design, operation and maintenance | Nghiem Trung Dung |
| 09:45-11:15 | Source control. | Nghiem Trung Dung |
| 11:30-12:15 | Source control (continued). | Nghiem Trung Dung |
| November 26, Tuesday | 08:00-09:30 | Ventilation for improving IAQ | Nghiem Trung Dung |
| 09:45-11:15 | Control by air cleaning | Nghiem Trung Dung |
| 11:30-12:15 | Control by institutional and educational measures | Nghiem Trung Dung |

### Course assignments

Course assignments will constitute a multi-part project:

* Assignment #1 (mostly in-class) – Identification of sources of indoor air pollutants in a type of indoor environments and their health effects.
* Assignment #2 – Development of a plan for the assessment of IAQ in a residential building or non-residential building.
* Assignment #3 – Development of measures for the control of indoor air pollution for a residential building or non-residential building.

To complete the assignments, the class will be divided into several groups (if possible).

**Assignment #1** will help students to understand the general issues of the course. The outcomes of the first assignment are reports for the identification of sources of indoor air pollutants and their health effects for specific cases (ppts and oral presentations).

**Assignment #2** will require a greater level of dealing with real work from students. Partly based on Assignment #1, it requires students to develop a plan for the assessment of IAQ for a real indoor environment.

**Assignment #3** will also require a greater level of dealing with real work from students. Partly based on Assignment #1, it requires students to develop a plan for the control of indoor air pollution for a real indoor environment.

**Literature**

Kathleen Hess-Kosa (2011), *Indoor Air Quality- The latest sampling and analytical methods*. Second Edition, CRC Press.

Thad Godish (2001), *Indoor environmental Quality*. Lewis Publishers.

Peter Pluschke (Editor) (2001), *The Handbook of Environmental Chemistry 4.F - Indoor Air Pollution*, Springer.

Maroni M., Seifert B. and Lindvall T. (Editors) (1995), *Indoor Air Quality - A Comprehensive Reference Book*, Elsevier Science B.V, The Netherlands.

Ad Bas (2004), *Indoor Air Quality - A Guide to Facility Managers, Second Edition*, The Fairmont Press, Inc. and Marcel Dekker, Inc.

Burroughs H. E. and Hansen S. J. (2004), *Managing Indoor Air Quality*, The Fairmont Press, Inc. and Marcel Dekker, Inc.

Robert Jennings Heinsohn and John M. Cimbala (2003), *Indoor Air Quality Engineering*, Marcel Dekker, Inc.

WHO (2010), *WHO Guidelines for Indoor Air Quality: Selected Pollutants*, Bonn.

Fisk W.J., Spencer R. K., Grimsrud D.T., Offermann F.J., Pedersen B., Sextro R. (1987), *Indoor air quality control techniques: Radon, Formaldehyde, Combustion Products*, Noyes Data Corporation, USA.

[Trinh Dinh Tran](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-1), [Truong Xuan Nguyen](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-2), [Hien Thi Thu Nguyen](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-3), [Ha Thi Le Vo](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-4), [Dung Trung Nghiem](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-5), [Tuyen Huu Le](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-6), [Duc Sy Dao](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-7) & [Noi Van Nguyen](https://link.springer.com/article/10.1007/s11270-020-04635-6#auth-8), 2020. Seasonal variation, sources and health risk assessment of indoor/outdoor BTEX at nursery schools in Hanoi, Vietnam. *Water, Air, and Soil Pollution*, Vol. 231, No. 273, <https://link.springer.com/article/10.1007/s11270-020-04635-6>.

Trinh Dinh Tran, Phuong Minh Nguyen, Dung Trung Nghiem, Tuyen Huu Le,  
Minh Binh Tu, Laurent Y. Alleman, Viet Minh Nguyen, Dong Thanh Pham,  
Ngoc Minh Ha, Minh Nhat Dang, Chieu Van Le and Noi Van Nguyen, 2020. Assessment of Air Quality in School Environments in Hanoi, Vietnam: A Focus on Mass‐Size Distribution and Elemental Composition of Indoor‐Outdoor Ultrafine/Fine/Coarse Particles. *Atmosphere,* Vol. 11, No. 519; <https://www.mdpi.com/2073-4433/11/5/519>.