Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus

Course description

Course title: **Thermo-fluid dynamics in high-rise and large structures**

Course code: 43080

Scientific sector: ICAR/01

Degree: Industrial and Mechanical Engineering (L-9) - 2016

Semester: **2**

Year: **III**

Academic year: 2020/2021

Credits: **6**

Total lecturing and exercising hours: 30 + 30

Attendence to course: suggested

Expected understanding and pre-collected knowledge:

General notion on; Thermo- and Fluid-Dynamics are of an advantage

Link:

Specific educational objectives (Aim-Learning of this course):

1. Noticing the decisive perticularities about large-scale (thermo)fluid-flow, both over and throughout the structure (recognizing the describing Physic-laws of such phenomena).

2. Overview of the most important concepts on environmental comfort and indoor air quality and belonging quantitative „cross-talks".

3. Choosing the representative structures (buldings, multi-storey car-parks, sport-halls) and transfering their architectnic drawings into the computational doman (learning to work with commercial Simulation-Software ANSYS-FLUENT in pre-processing phase).

4. Application of the mentioned relations (explaining the expected physical phenomena) thus-far as the initial conditions for a CFD-(computer-aided)-based observation on **Thermo-fluid dynamics in high-rise and large structures**

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5. After the generation of computational domain (with the technical plans of the chosen large-scale structure) - commiting the firther step of ANSYS-FLUENT pre-processing: the grid-generation (and explanation how the software-run is influenced by the density of the chosen grid).

6. Estimation of the „frame-work" for the run of the simulation (unsteady or steady fashion, choice of the particular model for turbulence-treatment, the choice of thermo-fluid-dynamic properties....) and pin-pointing their theoretical fundaments of lwas in Physics - just before „movement" of the CFD-based observation of the **Thermo-fluid dynamics in high-rise and large structures.**

Lecturer: **Medzid Muhasilovic** (GSM 00385 99 696 4328, WhatsApp 00387 65 145 282)

Scientific sector of the lecturer: **ICAR/01**

Teaching language: English and German

Office hours: **any day** (just before, please eMail to: **muhasilovic@gmail.com** or **WhatsApp to 00387 65 145-282**)

List of topics covered:

- Building´s Energy-Balance: observation of the ventilation-needs (and thermal-energy situation) regaring the energy-needs for a particular type of a building.

- Thermo-fluid wishfull, unexpected or unwanted behaviour: over and throughout a large-scale structure due to the (both forced and naturally-induced) ventilation.

- Both wanted and unwanted thermal gains and losses , solar radiation, hourly and monthly, averaged solar irradiation. Transient energy balance, thermal drain, detailed simulation methods of the task at hand.

- Heat-transfer and fluid-dynamic transfer properties during a **Thermo-fluid dynamics in high-rise and large structures**.

- According to the modern scientific papers in this field: the CFD-based observation on Environmental comfort: antropogenic influence, as well as the influence of any exothermal process onto the energy-balance in large-scale enclosures, sensible and latent heat, exchanges with the environment, thermal comfort, relevant factors affecting comfort in winter- and summer-time, evaluation indices, effective

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temperature. Indoor air quality and evaluation indexes. CFD-based research on **Thermo-fluid dynamics in high-rise and large structures** as an modern engineer´s instrument for measurements.

- Consulting both our European and international standards for task at hand:

Contents and application of the European and international standards about the calculation of energy-use for thermaly-temperd, large-scale ventilated enclosed space as well as the energy-performance of a such large-scale confined structures.

Teaching format: Lectures: electronic (PPT-)projections in a virtual class-room

Exercises: tool is a highly sophisticated CFD-(computer aided simulation)-based commercial software of ANSYS-FLUENT for exploration of **Thermo-fluid dynamics in high-rise and large structures** as well as in other confined spaces.

Learning outcomes:

(1) Knowledge and understanding:

- ....of Building-size and it´s application regarding the amount of energy, needed to entertain the planned thermo-fluid flow.

- Making the oppinion on Building´s „thermo-fluid-envelope" - the behavior of facade due to the heat- and mass-transfer - and all of this: relying on the CFD-based approach.

- Estimation of the Building-Occupants' thermal-comfort and indoor air-quality.

(2) Applying Knowledge and Understanding:

- Application of the CFD-based research on **Thermo-fluid dynamics in high-rise and large structures -** solving the main energy-balance´s calculation-aspects

and using simulation, which includes:

- calculating the heat- and mass-transfer in building´s components

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- assessing thermal comfort (according to the structure´s final use)

- dimensioning the (artificial) ventilation (both heating and cooling systems)

(3) Making judgments:

- Comparing different standard-specifications for the CFD-based explored building-ventilation with the gained results of CFD-based simulation.

- (based on scientific paper-reports thus far) - Making suggestion for the optimization on **Thermo-fluid dynamics in high-rise and large structures**

- Delegating the particular results (gained via CFD-based tool) in engineering area of thermal comfort for possible physical simulations (experiments) and if needed - making decisions about improvement-suggestions for the shape of the large-scale structure.

(4) Communication abbilities:

- Starting to use the technical nomenclature related to the object of interest.

- Preparing a report in form of (PPT-)presentation, while summarizing in this way some complex results and providing their appropriate technical and meaningful interpretation.

(5) To-be-learned skills

- Decomposing a complex task into a subtasks, finding the proper (theoretical) explanation in Physics and performing the observation of the matter at hand with CFD-based tool

- Consulting technical standards in this field of engineering.

Evaluation criteria and criteria for awarding marks:

Marks are attributed according to the following aspects:

- Explain the fundamental aspects of the task at hand (18= just about sufficient; 20 = satisfactory; 30 = full; 30 + Cum Laude = excellent)

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- Analysis ability to describe details and specific formulas/models that are to be used in the CFD-based investigation (18= just about sufficient; 20 = satisfactory; 30 = full; 30 + Cum Laude = excellent)

- Connecting the explored thermo-fluid situation with physical laws (18= just about sufficient; 20 = satisfactory; 30 = full; 30 + Cum Laude = excellent)

- Ability to give a presentations as summarized result (18= just about sufficient; 20 = satisfactory; 30 = full; 30 + Cum Laude = excellent)

Required means:

- a personal „LapTop" computer and paper-notebook for a quick remarks.

Interesting literature:

- H. Hens, 2012, Building Physics: Heat, Air and Moisture, Fundamentals and Engineering Methods with Examples and Exercises, Second Edition

- Carl-Eric Hagentoft, 2001, Introduction to Building Physics, Professional Pub Service

- (UNI) EN ISO 52016-1, 13791 and other relevant UNI EN ISO standards

- „Discussion of Equivalent Static Wind Loads on Long-Span Roof Structures" by J. Fu, Z. Xie, and Q. S. Li (in JOURNAL OF STRUCTURAL ENG. July 2008, Vol. 134, No. 7, pp. 1115–1128.)

- „Equivalent Static Wind Loads on Buildings: the New Model" by Xinzhong Chen and Ahsan Kareem (in JOURNAL OF STRUCTURAL ENG. October 2004 pp. 1424–1435.)

- „CFD-Based Investigation of the Response of Mechanical Ventilation in the Case of Tunnel-Fire", **M. Muhasilovic, J. Duhovnik** https://doi.org/10.5545/sv-jme.2009.091 Published 2012 in " Strojniski Vestnik-journal of Mechanical Engineering" Ljubljana Slovenija

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