# Course offered for the PhD program
# in Safety, Risk and Vulnerability
## Curriculum in Risk and Resilience Engineering for Natural, Industrialized and Built Environments

## and in Civil, Chemical and Environmental Engineering
## Curriculum in Wind Science and Engineering

**A.Y. 2022/2023 (XXXVIII cycle)**

(Possibility of participation for students in other PhD cycles or other PhD courses)

## 1. Title

Monitoring and analysis of full-scale downburst events and their effects on structural response

## 2. Course description

This course aims at introducing the students to thunderstorms and the severe weather phenomena associated with thunderstorms. Thunderstorms are the most vigorous clouds (cumulonimbus clouds) in the Earth's atmosphere, and they are responsible for hail, lightning, intense rainfall, downburst winds, and tornadoes. Downburst winds are a major cause of damage around the globe. Design wind velocities with mean return periods greater than 10–20 years are often associated with such events, but the complexity of thunderstorms makes it difficult to establish physically realistic and simple models to deal with the effects of downbursts on structures. New advances in monitoring thunderstorm outflows and their actions on slender structures have been achieved during the ERC Project THUNDERR (http://www.thunderr.eu/), which is expected to shorten the persistent gap between wind engineering and atmospheric sciences with the aim of designing safer and cost-efficient constructions.
The aim of the course is to provide the basic knowledge of downburst winds and their effects on structures and infrastructures, as well as the advances achieved in this research field through the Project THUNDERR.

## 3. Course Organization

The course will be offered in a hybrid format. Synchronous, in-person lectures will be offered to PhD students at University of Genoa. On-line video-streaming lectures will be available to other students. Lecture recordings will also be made available to participants.

The course consists of lectures and tutorials, in which the active involvements of the participants is required.

1. Monitoring and analysis of downburst events (6 hours)
   - 1.1. Physics of thunderstorms and downburst outflows, wind field measurements through anemometric and remote-sensing techniques (e.g., lidar, radar) (4 hours; Prof. M. Burlando)
   - 1.2. Tutorials: analysis of downburst records and vertical wind profiles reconstruction by lidar wind velocity profilers (2 hours; Dr. F. Canepa)
2. Downburst effects on structural response (6 hours)
   - 2.1. Introduction to wind actions on structures, peculiarities of thunderstorm induced effects and models for structural response prediction, thunderstorm structural health monitoring for the safety of structures (4 hours; Prof. M. P. Repetto)
   - 2.2. Tutorials: analysis of simultaneous wind velocity and structural response records under thunderstorm event (2 hours; Dr. A. Orlando)

## 4. Instructors

Prof. Massimiliano Burlando, Prof. Maria Pia Repetto, Dr. Federico Canepa, Dr. Andrea Orlando

## 5. Duration and credits

12 hours (2.5 credits)

## 6. Activation mode and course timetable

The minimum number of participants to activate the course is 3.

| Week No. | Day | Date | Time (CET) | Room | Zoom link |
|---|---|---|---|---|---|
| **26** | Tuesday | 2023-07-04 | 14-16 | A12 | link |
| | Wednesday | 2023-07-05 | 14-16 | A12 | link |
| | Thursday | 2023-07-06 | 14-16 | A12 | link |
| **27** | Thursday | 2023-07-13 | 14-16 | A12 | link |
| **28** | Monday | 2023-07-17 | 14-16 | A12 | link |
| | Tuesday | 2023-07-18 | 14-16 | A12 | link |

Join Zoom meeting:
https://us06web.zoom.us/j/89906349353?pwd=R3FHTmNZQnR1UkZKYm4zdWFjYVdoZz09
Meeting ID: 899 0634 9353
Passcode: 192250

## 7. Registration

Please, send an e-mail for confirmation to Prof. Massimiliano Burlando, massimiliano.burlando@unige.it.

## 8. Final exam

At the end of the course, a final oral examination will be held.

## 9. Recommended references

Burlando M., D. Romanić, G. Solari, H. Hangan, and S. Zhang (2017) Field data analysis and weather scenario of a downburst event in Livorno, Italy on 1 October 2012. Mon. Wea. Rev. 145, 3507–3527. DOI: 10.1175/MWR-D-17-0018.1

Canepa F., M. Burlando, and G. Solari (2020). Vertical profile characteristics of thunderstorm outflows. J. Wind Eng. Ind. Aerodyn. 206, 104332. DOI: 10.1016/j.jweia.2020.104332

Solari G., M. Burlando, and M.P. Repetto (2020). Detection, simulation, modelling and loading of thunderstorm outflows to design wind-safer and cost-efficient structures. Journal of Wind Engineering and Industrial Aerodynamics 200, 104142, pp. 18, DOI: 10.1016/j.jweia.2020.104142

Zhang S., G. Solari, P. De Gaetano, M. Burlando, and M.P. Repetto (2018) A refined analysis of thunderstorm outflow characteristics relevant to the wind loading of structures. Probabilistic Engineering Mechanics 54, 9–24. DOI: 10.1016/j.probengmech.2017.06.003

References to other specific textbooks and journal/conference articles will be provided during lectures.