Addressing problems of heat and mass transfer in turbulent flows is the most frequent situation for everyone concerned with process engineering problems. However, the complexity of phenomena involved in these problems implies a multiplicity of analysis and simulation techniques, which require an in-depth knowledge and specific training, but that are not generally provided on graduate master courses. The 19th UIT Summer School aims at providing engineers, PhD students and post-doc researchers with the most effective theoretical, computational and experimental tools to address these problems. The Course is organized in five coordinate series of lectures intended to address questions like: what are the physical phenomena concerned with turbulence? How do turbulent flows behave? How can they be quantitatively described? Which are the computational models? Which the experimental techniques? Numerous examples from both standard and leading-edge engineering problems of fluid dynamics and heat transfer will help in enlightening and grasping both foundations and applications of this challenging subject.

CONTRIBUTORS

Prof. **Diego Angeli**, Università degli Studi di Modena
Prof. **Dario Ambrosini**, Università degli Studi di L'Aquila
Prof. **Michele Ciofalo**, Università di Palermo
Prof. **Alessandro Chiarini**, Politecnico di Milano
Prof. **Fabio Cozzi**, Politecnico di Milano
Prof. **Adriano M. Lezzi**, Università di Brescia
Prof. **Alfonso Niro**, Politecnico di Milano
Prof. **Pietro Poesio**, Università di Brescia
Prof. **Maurizio Quadrio**, Politecnico di Milano

ADDITIONAL INFORMATIONS

Additional info about the Summer Schools can be found on the website: **www.uitonline.eu.**
For any further questions and requests, please contact: Professor Alfonso Niro, Director of 19th UIT Summer School alfonso.niro@polimi.it

CREDITS FOR PHD STUDENTS

PhD Students can gain credits according to the regulation of their own PhD School. In addition to the Attendance Certificate, a Proficiency Certificate can be obtained upon submission of a report on one of topics addressed in the program.

APPLICATION AND FEES

The registration fee is 800,00 Euros and includes attendance to the Summer School, coffee breaks during the lessons, and full board treatment from the dinner of Sunday 28 August to the lunch of Saturday 3 September. Each participant is kindly asked to confirm at the reception his/her presence at the lunch of Saturday 3.
The 50% of registration fee (€ 400,00) must be paid before August 5, 2022, following the instructions given within the registration form. The remaining 50% (€ 400,00) must be paid directly during the check-in at Certosa di Pontignano.
Please, to apply download **(here)** and complete (in PDF or RTF format) the registration form, and kindly send it by e-mail, before August 5, 2022, to:
info@lacertosadipontignano.com
Adriano.lezzi@unibs.it

LOCATION

The 19th Summer School will be held in the prestigious Ancient Certosa di Pontignano, a unique place where nature, history and hospitality blend together in a memorable harmony, at a few kilometers from Siena, in the heart of Chianti, on a hill dominating the town. Further information can be gathered directly at Certosa website (www.lacertosadipontignano.com).

UIT Unione Italiana Termofluidodinamica

19th UIT Summer School

29 August - 2 September 2022

Starry night , Vincent Van Gogh 1889

Give welcome to chaos, because order hasn't worked.
Karl Kraus

HEAT AND MASS TRANSFER IN TURBULENT FLOWS: MODELING AND MEASUREMENT TECHNIQUES

Director: Professor Alfonso Niro
Politecnico di Milano

Certosa di Pontignano (Siena)

CARTHUSIA PONTINIANI

Programme

	Monday 29 August	Tuesday 30 August	Wednesday 31 August	Thursday 1 September	Friday 2 September
8.30	*A. Niro* *Nature, origin and features of turbulence. The scale multiplicity of turbulent motion.*	*P. Poesio* *Taylor hypothesis; Kármán-Howarth equation. Isotropic turbulence in Fourier space.*	*A. Chiarini* *Structure of turbulence over and after a bluff body.*	*M. Quadrio* *One-equation model (Spalart-Allmaras). Two-equation models: the k-epsilon model.*	*F. Cozzi* *Statistical methods in the experimental description of turbulent flows. Spectral decomposition.*
9.20	*A. Niro* *Equations of fluid motion.*	*P. Poesio* *Navier-Stokes equations and turbulent kinetic energy equation in spectral form; energy spectrum.*	*A. Chiarini* *Surface roughness effects: how to describe a rough surface.*	*A. Chiarini* *The k-omega and k-omega-SST models. Introduction to the Reynolds stress models (RSM).*	*F. Cozzi* *Laser doppler velocimetry (LDV), particle image velocimetry (PIV).*
10.15	***Coffee break***	***Coffee break***	***Coffee break***	***Coffee break***	***Coffee break***
10.45	*A. Niro* *Fluctuations and Reynolds decomposition: mean-flow equations.*	*P. Poesio* *Temperature fluctuations and associated scales; internal energy equation in real and Fourier space.*	*A. Chiarini* *Shortcomings of classical description of roughness.*	*A. Chiarini* *Critical evaluation of RANS results based on DNS*	*F. Cozzi* *Measurements and data processing in turbulent flows.*
11.40 **12.30**	*A. Lezzi* *Stability and transition to turbulence: linear stability analysis of laminar flows.*	*D. Angeli* *Free shear flows: the round jets.*	*M. Quadrio* *Active and passive flow control.*	*D. Ambrosini* *Flow visualization techniques*	*M. Ciofalo* *Sub-grid-scale (SGS) modeling. The Smagorinsky sub-grid model.*
13.00	***Lunch***	***Lunch***	***Lunch****	***Lunch***	***Lunch***
14.15	*A. Lezzi* *Flow stability between coaxial rotating cylinders. Taylor and Goertler vortices.*	*D. Angeli* *Other free shear flows: plane jets; mixing layer, plane wake.*	*M. Ciofalo* *Introduction to modelling and simulation,space and time filtering: DNS, LES, RANS.*	*M. Ciofalo* *Large Eddy Simulation (LES) and filtering.*	*M. Ciofalo* *LES in wavenumber space. Further residual-stress models.*
15.10	*A. Lezzi* *Orr-Sommerfeld equations; BL stability; Tolmienn-Schlichting waves. Non-linear theory.*	*M. Quadrio* *Turbulent wall flows. Multiple layers and length scales; law of the wall and Prandtl's friction law.*	*M. Quadrio* *RANS equations and turbulent viscosity models. The turbulent viscosity hypothesis.*	*M. Ciofalo* *Filtered conservation equations. Modeling unresolved scales.*	*M. Ciofalo* *Special topics 3: Simulations of turbulent flows in specific conditions.*
16.00	***Coffee break***	***Coffee break***		***Coffee break***	***Coffee break***
16.30	*P. Poesio* *Introduction to the statistical description of turbulence.*	*D. Angeli* *Temperature law of the wall. The Reynolds analogy for the Stanton number.*		*M. Quadrio* *Special topics 1: Machine learning for turbulence modelling: an overview. PINN.*	*D. Ambrosini* *Techniques for temperature and temperature-field measurements*
17.20 **18.15**	*P. Poesio* *Homogeneous and isotropic turbulence in real space: structure functions.*	*A. Chiarini* *Coherent structures and turbulence wall cycle. Superstructures.*		*M. Quadrio* *Special topics 2: Fluid dynamics of the human nose (with clinical implications).*	*D. Ambrosini.* *Special topics 4: Advanced techniques for temperature-field measurements.*
20.00	***Dinner***	***Dinner***	***Dinner***	***Dinner***	***Dinner***

* On Wednesday 31st, the lunch is at 12:45 so the lessons in the afternoon start and stop 15 min in advance of the scheduled time