Joint ICTP-IAEA Course on Theoretical Foundations and Application of Computational Fluid Dynamics in Nuclear Engineering

13 - 17 September 2021
An ICTP-IAEA Virtual Meeting
Trieste, Italy

The course will provide graduate students and professionals with theoretical foundations and examples for application of computational fluid dynamics (CFD) modelling in nuclear engineering. The need for high fidelity nuclear reactor thermal hydraulic simulations has led to increased application of the CFD codes that are prevailing substitute of currently established one dimensional system thermal hydraulics codes and coarse mesh sub-channel analyses codes. Therefore, CFD constitutes the "third approach" in the philosophical study and development of the whole discipline of fluid dynamics. Combining the power of experimentation and theory, this approach has made possible the accounting of flow fields in complex geometries. This course will outline these aspects and provide the participants with hands-on examples.

Directors:

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Local Organiser:

A. CELANI, ICTP, Italy

Description:

The course will build a theoretical understanding on the science of CFD and its applications in nuclear engineering supported by various hands-on practical examples. Knowledge transfer will be facilitated between the international experts as lecturers, and students, professionals and engineering analysists, as participants. Given that the CFD codes, which have empirical models for simulating heat transfer, turbulence, single-phase and multi-phase flow, are currently available along with general application-oriented training in their use, the focus of this course is on providing the required background about the embedded models with the goal to improve the participants' theoretical foundation for CFD applications in the area of nuclear engineering.

Along with the theoretical lectures and hands-on learning examples, the course will include comprehensive overview of the history of CFD development and its applications in nuclear engineering, including development, status, and challenges.

Topics:

1. History and theory of computational fluid dynamics
1.1 Brief review of vector calculus and discretization process with emphasis on domain and physical modelling of phenomena
1.2 Navier Stokes governing equations
1.3 Finite volume method and two-phase approximations in CFD
1.4 Mathematical and numerical solution methods

2. Basics of turbulence modelling – from RANS to DNS
3. Application of CFD codes in nuclear reactor design and safety analysis
4. Multi-scale approach to nuclear reactor analysis: system analysis approach vs CFD approach
5. Uncertainty quantification and error analysis
6. Hands on session: Mesh generation and simulation using OpenFOAM

Prerequisites:

As part of the application, participants should submit min 1-page to max 2-page original essay, covering one of the course topics of their choice. The best five essays will be selected for participants to present at specially designated session (for which they will need to develop up to 10 slides and present in no longer than 10min time slot) – other participants and lecturers will be asked to vote. At the closing of the course, the organizer will announce the best voted presenter.

Lecturers:

D. BESTION, CEA, France
E. FREDERIX, NRG, Netherlands
A. GERSCHENFELD, CEA, France
G. GIUSTINI, Imperial College London, UK
Y. HASSAN, Texas A&M, USA
S. KELM, FZJ, Germany
B. KHUWAILEH, University of Sharjah, UAE
A. MANERA, ETH Zurich, Switzerland
E. MERZANI, Pennsylvania State University, USA
K.R. QURAISHI, PIEAS, Pakistan
V. PETROV, PSI Switzerland
F. ROELOFS, NRG, Netherlands
Y. SATO, Paul Scherrer Institute, Switzerland
H. YUAN, ANL, USA

How to apply:

Online application:
http://indico.ictp.it/event/9658/

Female scientists are encouraged to apply.

Registration:

There is no registration fee.

Deadline:

1 September 2021

IAEA
International Atomic Energy Agency

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