Graduate Program for Integration of Mechanical Systems
International Subject for MC students

Special Lecture Series on System Integration 1

GP-Mech program will hold the Course of "Special Lecture Series on System Integration 1". Please find more details as follows.

- Date and Time:

1. June 30 (Mon) 9:00–11:45
2. July 1 (Tue) 9:00–11:45
3. July 2 (Wed) 9:00–11:45
4. July 3 (Thu) 9:00–11:45
5. July 7 (Mon) 9:00–11:45
6. July 8 (Tue) 9:00–11:45
7. July 9 (Wed) 9:00–11:45
8. July 10 (Thu) 9:00–11:45
9. July 11 (Fri) 9:00–11:45

- Lecture style: Face-to-Face Lecture
- Venue: Lecture Room #8
- Credit: 2
- Language: English
- Lecturer: Prof. F.D. Witherden (Texas A&M University)

*If you are interested and would like to attend this lecture, please send an email to the following address ~~【by June 10th】~~【by June 24th】.
Attn: Watanabe(Ms) Email: gp-mech@grp.tohoku.ac.jp

*Students can claim credits as Related Subject in the Graduate School of Engineering.

**This subject cannot be registered on Student Affairs Information System. Registration procedures will be announced later.

Unsteady Computational Fluid Dynamics

Computational fluid dynamics (CFD) is a relatively young discipline, having emerged during the last 50 years. During this period advances in CFD have been paced by advances in the available computational hardware, which have enabled its application to progressively more complex engineering and scientific problems. At this point CFD has revolutionised the design process in the aerospace industry, and its use is pervasive in many other fields of engineering ranging from automobiles to ships to wind energy. It is also a key tool for scientific investigation of the physics of fluid motion, and in other branches of science such as astrophysics. Additionally, throughout its history CFD has been an important incubator for the formulation and development of numerical algorithms which have been seminal to advances in other branches of computational physics.

For the past 20 years CFD has been on a plateau, with the majority of industrial simulations being steady-state simulations employing Reynolds-averaged Navier–Stokes (RANS) models. Such simulations, however, are limited in their ability to accurately predict the dynamics of turbulent flows with separation. This has restricted the use of CFD to a small, but nevertheless important, region of the operating design space. However, thanks to recent advances in computing hardware and numerical methods, it has recently become possible to perform unsteady scale-resolving simulations of flow problems which are of industrial importance.

In this course I will give an overview of the state-of-the-art schemes for performing unsteady CFD simulations of complex geometrical configurations on modern hardware platforms. Specifically, the course will introduce the high-order flux reconstruction (FR) approach of Huynh and provide detailed insight into its implementation on CPU and GPU hardware at extreme scale. Throughout the course the importance of algorithm/hardware co-design will be emphasised.

Instructor: Prof. F.D. Witherden

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Outline

1. Introduction to unsteady CFD
2. Flux Reconstruction in One Dimension
3. Extension to Diffusion and Multiple Dimensions
4. Time Stepping and Navier–Stokes
5. Elements of Modern Computing Hardware
6. Implementation
7. Stabilisation and Shock Capturing
8. Pre- and Post-Processing
9. Learning Dynamics from Data and Future Challenges

Bio Sketch

Freddie Witherden studied Physics with Theoretical Physics at Imperial College London between 2008–2012 earning an MSci degree with first class honours. In September of 2012 Freddie started a PhD in computational fluid dynamics in the department of Aeronautics at Imperial College London under the supervision of Dr Peter Vincent and graduated in December 2015. He is currently an Assistant Professor of Ocean Engineering at Texas A&M University.

Freddie's main research interests are in the development of simple and efficient high-order methods for modern CPU/GPU platforms. The primary vehicle for this is the flux reconstruction (FR) approach proposed by Huynh at NASA Glenn in 2007. Using the FR approach, it is possible to recover both discontinuous Galerkin and spectral difference schemes along with various new and novel methods. Furthermore, the approach is also extremely well suited to the requirements of modern many-core architectures.