Theme of the Course :

Turbulence is ubiquitous in nature, and most industrial flows are predominantly turbulent. However, the analysis of turbulent mass, momentum and scalar transport remains one of the most challenging areas of thermo-fluid mechanics due to the wide range of length and time scales encountered in typical turbulent flows. This scale separation is a strong function of turbulent Reynolds number, and the complex interactions that occur due to non-linearity of governing Navier-Stokes equations. A complete physical understanding of turbulent flows necessitates the resolution of a rich variety of multi-physics phenomena. To date, none of the existing experimental and analytical methods is able to cover the full range of scales and associated phenomena occurring in the turbulent flows.

The proposed course will discuss the current state-of-art of turbulence modelling in the context of both RANS and LES, and the fundamental physical principles which underpin these model developments. It will also be demonstrated in this course how the fundamental understanding obtained from DNS feeds into the development of high-fidelity RANS and LES turbulence models. It is important to recognize that this area is extremely dynamic, and continuously evolving with time. This is not meant to be a CFD course, but it focuses on the science of turbulence modelling, which is necessary for computational simulations of turbulent mass, momentum and scalar transport in engineering applications. The topics, which will be covered in the proposed course, will not only provide an exposure to the conventional methods of turbulence modelling but also to some of the newly developed methodologies which have started to yield promising results.

Lectures in this course will be prepared based on the materials from a range of different courses which ran successfully in the past under the guidance of the course instructor in the University of Cambridge, University of Liverpool and Newcastle University. The proposed course will draw heavily on the course instructor's own research papers, and the book chapters authored by him. The course is planned to have a duration of 5 days comprising 10 hours of lectures and 6 hours of tutorial including assignment and discussion.

Course Content

- Introduction to governing equations and their significances.
- Recapitulation of the structure of turbulent boundary layer and scalar transport in turbulent boundary layers.
- Introduction to Reynolds decomposition and Favre decomposition, their interrelation and necessities, Introduction to LES filtering.
- Introduction to different simulation methods for turbulent flows, their strengths and limitations.
- Physics of turbulence transport and its modelling
- Closure problem of turbulence and the need for turbulence modelling.
- Computational modelling of Reynolds stress/sub-grid turbulent stress closures.
- Essential concepts of molecular mixing and turbulent mixing.
- Length scales of mixing and the significance of scalar variance and dissipation rate.
- Computational modelling of scalar variance and scalar dissipation rate.
- Closure of Reynolds scalar flux/sub-grid scalar flux.

Objective of the Course :

The primary objectives of the course are as follows:

- ✓ Recapitulation of the fundamental physics of fluid turbulence and heat and mass transfer.
- ✓ Exposure to different simulation methodologies for turbulent flows.
- ✓ Awareness of alternative methodologies of turbulent modelling for both incompressible and compressible flows.
- ✓ Enhancing the capability of the participants to identify appropriate turbulence models, and simulation techniques, formulate new models, and solve challenging turbulent flow problems.

GIAN
Global Initiative of Academic Networks

Ministry of Human Resource Development, **Government of India**

5 Days course on

Computational Modelling of Turbulent Flow and Scalar Transport

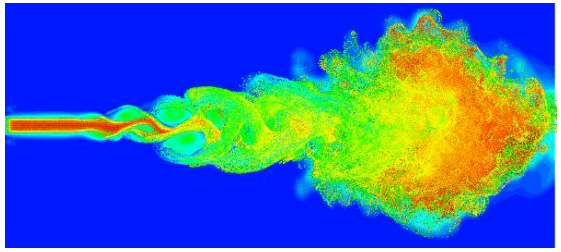
March 27-31, 2023

Course Instructor

Prof. Nilanjan Chakraborty
Professor,
Fluid Dynamics School of Mechanical and Systems Engineering of Newcastle University

Course Coordinator

Dr. Rabindra Nath Barman
Assistant Professor,
Department of Mechanical Engineering
&
Dr. Partha Sarathee Bhowmik
Associate Professor
Department of Electrical Engineering



Organized by:

Department of Mechanical & Electrical Engineering
National Institute of Technology Durgapur-713209
Website: www.nitdgp.ac.in

Foreign Teaching Faculty

Prof. Nilanjan Chakraborty is currently a Professor of Fluid Dynamics at the School of Mechanical and Systems Engineering of Newcastle University. Previously he was a senior lecturer at the School of Engineering of the University of Liverpool. He joined University of Liverpool as a lecturer in 2005 and was promoted to a senior lectureship in 2008. He moved to his current position in 2011 where he heads the Fluid Dynamics and Thermal Systems research group. His research interests.include Direct Numerical Simulation (DNS) of turbulent combustion, turbulence and combustion modelling, Reynolds Averaged Navier Stokes (RANS) and Large Eddy Sim-ulations (LES), turbulent convection, natural convection of non- Newtonian fluids, Melting/solidification related heat transfer problems in classical manufacturing (e.g. Casting, Welding) and laser aided manufacturing applications
(e.g. Laser Surface Alloying).

About the Departments

Department of Mechanical Engineering is the largest and one of the oldest Departments of the Institute started in the year 1960.It offers both undergraduate(B.TECH)and postgraduate(M.TECH) degree course apart from doctoral programme. The annual intake of the UG course is 180+ and that of the PG course is 20+ for three specialization each, totalling 60+. At present about 30 students are doing their doctoral research with the department. The department comprises of well-qualified faculty, supporting staff and suitably equipped laboratory. Department of Mechanical Engineering offers three PG course with specialization: Machine Design, Thermal Engineering, Fluid Mechanics and Heat Transfer. It has a vision-"advancement of the society through excellence in teaching, research and innovation and services that exploits the rapidly changing technical diversity of Mechanical Engineering".

The Electrical Engineering department was established in the year of 1960. Presently the department offer B. Tech in Electrical Engineering, with intake capacity of 100 students, M. Tech in Power Systems and Power Electronics & Machine Drives, each have intake 20 students, and PhD program. The students from different states of India and also from different countries are presently studying in the department. The department has 17nos. qualified and highly motivated faculty members with various specializations, is equipped with around 15 different laboratories.

About the Institute

National Institute of Technology Durgapur, formerly known as Regional Engineering College, Durgapur (also known as REC Durgapur or RECDGP) is an Institute of national importance created under the act of parliament is a public technical university in the city of Durgapur in West Bengal, India. Founded in 1960, it is one of India's oldest technical universities. It is located on a campus of 187 acres (0.75 km^2).NIRF ranked the university 7th among the NITs, 34th for engineering, and 72nd overall in India in 2022. NIT Durgapur offers UG and PG programs in disciplines spanning engineering, science, architecture, and management. The institute has 14 departments with about 224 faculty members and more than 4000 enrolled students. The institute imparts quality technical education and focus on research and innovation to cater to the need of the country. The mission of the institute is to initiate the students to research-oriented teaching-learning environment in the Institute with a focus on excellence and innovation.

Course Coordinator

Dr. Rabindra Nath Barman is Assistant Professor in the Mechanical Engineering Department, NIT Durgapur. He received his B, Tech., M. Tech and Ph. D. from Jadavpur University. He has over 12 year's research experience in the water resources & hydraulic Engineering. He has published more than 40 papers in reputed journals and serving as a reviewer on several reputed journals. He is the principal co-author of the two Springer monographs. He is also a project investigator of research projects granted by DST, IEI and AICTE. His research are includes transport phenomena, fluid flow and heat transfer applications.

Dr. Partha Sarathee Bhowmik is Associate Professor in the Electrical Engineering Department, NIT Durgapur. He received his Ph. D. from Jadavpur University. He is also a project investigator of research projects from DST and MHRD. His research interest includes Signal Processing, Soft Computing, and Power Systems stability, FACTS Devices, Smart Grid/Micro Grid, Renewable Energy and Instrumentation.

Registration Fee

Participants from abroad	US $200
Indian Participants	
Industry/ Research Organizations	INR 3,000
Research Scientists/ Faculty	INR 2,000
Students	INR 1,000

The above fee includes all instructional materials, computer use for tutorials & and assignments, accommodation, and meals.

The number of participants for the course will be limited to fifty.

Who can Participate:

Industrial scientists from manufacturing, service and government organizations, including R&D laboratories as well as students or Faculty from academic institutions and technical institutions, who want to improve/understand practical issues and correlate with theoretical concepts.

Important dates and venue

Last date for Registration	28-02-2023
Course schedule	March 27th – 31st, 2023
Venue	National Institute of Technology Durgapur Mahatma Gandhi Avenue, Durgapur, West Bengal, INDIA

Contact Details

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