Course Overview

Combustion emissions from fossil fuels and their detrimental contribution to global warming, climate change, and environmental air-pollution are well-known. Strenuous efforts are being made to replace fossil fuels and use renewable energy sources as much as possible. International efforts such as the Paris climate accord has been agreed to reduce greenhouse gas emissions and limit global temperature rise in the future. Meeting this target will require a considerable reduction in transport emissions, which currently account for about 24% of the economy-wide total. The current energy systems mainly rely on fossil fuels for transportation and power generation. New and more environmentally friendly energy vectors have emerged to reduce the use of carbon-based fuels.

The use of fossil fuels in transport, mainly gasoline and diesel, has become a major problem. In addition to the cost of these fuels, diminishing resources, fuel security issues, transport fuels are causing major environmental problems in large cities in some countries. According to World Health Organisation (WHO) data, the highest urban air pollution levels are present in countries in Eastern Mediterranean and South-East Asia regions, with annual mean levels often exceeding 5-10 times WHO limits. Alternative fuels which do not contribute to further pollution are required. Cutting emissions to the extent required demands a multi-faceted approach including electrification and increased deployment of low carbon gas/liquid fuels. In this context, hydrogen is seen as a potentially widespread fuel for the future due to several reasons. Hydrogen has the potential to facilitate significant reductions in energy-related CO2 emissions and to contribute to limiting global temperature rise. As a transport fuel, it has the potential to create clean environments and reduce harmful emissions. Hydrogen is considered as a promising energy carrier because of the high energy density on a mass basis, and its carbon-free property. Hydrogen can be generated from different sources, including fossil fuels, renewable fuels, or electrolysis of water. Conventional hydrogen production methods using fossil fuels include steam reformation of natural gas, partial oxidation, and gasification. Hydrogen can also be utilised in many ways. Hydrogen vehicles using Fuel Cell technologies, direct hydrogen burning in internal combustion engines, burning hydrogen mixtures in gas turbine systems are some examples where hydrogen can make a significant impact.

This course aims to introduce hydrogen technologies with an emphasis on hydrogen as a future fuel. It will cover major topics in hydrogen generation, utilisation and safety and will also introduce the participants to hydrogen infrastructure and the future hydrogen economy. Fundamentals of renewable hydrogen generation methods using renewable feedstocks, wind power, solar energy, and water electrolysis technologies are covered and concepts such as grid power-to-gas (P2G), hydrogen as an energy carrier, decarbonisation of gas networks and low carbon electricity generation, hydrogen fuel cell technologies, thermo-chemical hydrogen generation technologies and storage methods are covered.

Course Contents

- ☆ Hydrogen: Occurrence; physical and chemical properties; hydrogen as a future fuel
- ☆ Hydrogen generation technologies.
- ☆ Hydrogen storage technologies.
- ☆ Hydrogen utilisation technologies.
- ☆ Hydrogen in engines.
- ☆ Hydrogen injection into national gas grids, role of hydrogen in decarbonisation.
- ☆ Hydrogen in other equipment: Hydrogen combustion in other combustion equipment and implications in existing boilers and gas turbines.
- ☆ Modelling: Characteristics and modelling of hydrogen flames & combustion processes; Pure hydrogen use in the future - requirements for combustion equipment design
- ☆ CFD modelling of hydrogen combustion devices.
- ☆ Hydrogen infra-structure: Safety & environmental aspects of hydrogen; Hydrogen codes and standards; Hydrogen sensing & detection; Hydrogen safety, fires and explosion research.

Objectives

The primary objectives of this short course are as follows:

- To provide an understanding of the role of hydrogen as a clean fuel of the future.
- To provide good knowledge and an understanding of hydrogen generation techniques from renewables.
- To provide a knowledge of methods of hydrogen storage technologies.
- To provide a good knowledge on understanding of hydrogen utilisation technologies.
- To provide an understanding of the role of hydrogen in decarbonization of transport and other energy vectors.

GIAN
Global Initiative of Academic Networks

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

5 Days* GIAN Course on

Use of hydrogen as a future fuel

*(Lectures: 20 hours)

December 20 - 24, 2021
(Monday - Friday)

Course Instructor
Prof. Weeratunge Malalasekera
Professor of Computational Fluid Dynamics and Heat Transfer,
School of Mechanical, Electrical and Manufacturing Engineering,
Loughborough University, UK

Course Coordinator
Dr. Shanmugam Dhinakaran
Department of Mechanical Engineering, IIT Indore, INDIA
Course Website: http://people.iiti.ac.in/~sdhina
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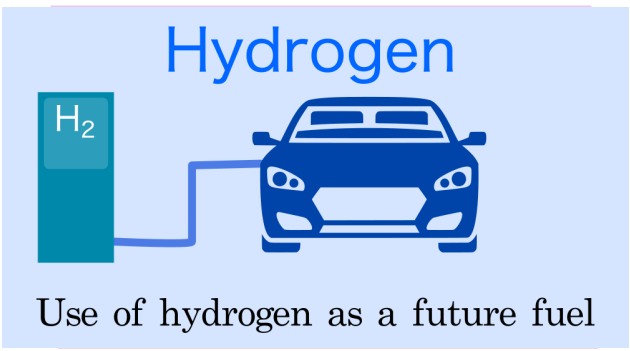
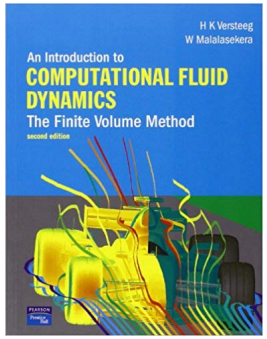


The Centre for Fluid Dynamics
Department of Mechanical Engineering
INDIAN INSTITUTE OF TECHNOLOGY INDORE
Simrol, Indore, INDIA

Teaching Faculty

Prof. Weeratunge Malalasekera is a Professor of Computational Fluid Dynamics & Heat Transfer at the Loughborough University, United Kingdom. Prof. Malalasekera maintains good collaborative links with a number of internationally leading research groups. His research interests include modelling and simulations of IC engines; Investigations into the performance of CCGT power plants; Development and investigations into energy storage solutions; Investigation into hydrogen applications, combustion, deflagration and flame propagation in hydrogen mixtures and Large eddy simulations of premixed and non-premixed flames.

Prof. Malalasekera contributes to all levels in undergraduate teaching and runs and contributes to the M.Sc Programme in Mechanical Engineering. Computational Fluid Dynamics and Heat Transfer are the main subjects taught. He is the co-author of the textbook entitled 'An introduction to Computational Fluid Dynamics: The Finite Volume Method'. First published by Longman Higher Education in 1995, this book as become a widely used popular CFD course text at many universities worldwide. An enhanced second edition of this book covering advanced topics and recent development in CFD has been published in February 2007, by Pearson Higher Education. By popular demand, a number of international editions (Chinese, Asian, Japanese, Greek and Korean) have also been published.



The widely adopted text book of Prof. Weeratunge Malalasekera on Computational Fluid Dynamics

Course Coordinator

Dr. Shanmugam Dhinakaran is an Associate Professor at the Department of Mechanical Engineering, Indian Institute of Technology Indore, India. He received his PhD in the area of Computational Fluid Dynamics and Heat Transfer from IIT Kharagpur, India in 2008. Before joining IIT Indore as an Assistant Professor in 2012, he has worked as a post doctoral researcher at the Université de Pau et des Pays de L'Adour, France; Universidade do Minho, Portugal; Faculdade de Engenharia da Universidade do Porto, Portugal and Université de Valenciennes et du Hainaut-Cambrésis, France.

Dr. Dhinakaran is also an adjunct faculty in the Department of Biosciences and Biomedical Engineering, IIT Indore. He is the coordinator of The Centre for Fluid Dynamics, IIT Indore. Bluff body flows; Non-Newtonian fluid flows; Heat transfer in Porous media; Nanofluids and Biofluid Mechanics are his research interests.

Who should attend?

- **Prerequisite**: Some knowledge of combustion, thermo-fluids and heat transfer would be useful.
- Executives, engineers and researchers from academia, industry and government organizations including R&D laboratories with a background in aerospace, automotive, mechanical, and chemical engineering.
- Students at advanced levels (BTech/MSc/MTech/PhD) or Faculty from reputed academic institutions and technical institutions.

e-Certificate

Participation certificate will be give to all the participants.

Event Type

This is an international event. Lectures will be offered in the online mode only.

Registration Fee

UG & PG Students	Rs. 1,000 + 18% GST
Research Scholars	Rs. 1,500 + 18% GST
Post Doctoral Researchers	Rs. 2,000 + 18% GST
Faculty members from Private Colleges	Rs. 2,500 + 18% GST
Faculty members from Government Institutes	Rs. 8,000 + 18% GST
Scientists from Industry, R&D Organizations	Rs. 25,000 + 18% GST

The above fee is only for participation in the event in the online mode. Lecture materials, if provided, will be in the form of soft copy only.

How to Register?

1. Send an e-mail to the coordinator (sdhina@iiti.ac.in) expressing your interest and wait for acceptance.
2. If accepted, pay the relevant fee online and send the details to the course coordinator.

Important dates and venue

Last date for Registration	December 19, 2021
Course schedule	December 20 - 24, 2021
Venue	Online mode only

Contact Details

Almost all the information regarding eligibility, fee payment, etc., are available in the course website. If you have any other queries, you may write to or call the course coordinator.

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