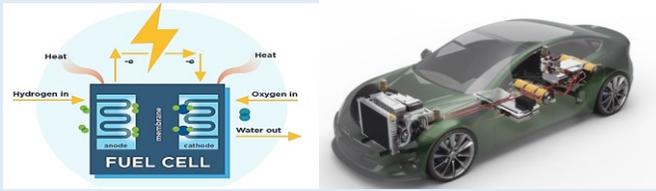


A short course on Fuel Cell Technology and its Engineering Aspects



November 2-4, 2023

Course Instructor



Professor S. T. Revankar

Professor, School of Nuclear Engineering
Purdue University, West Lafayette, USA
(<https://engineering.purdue.edu/~shripad/>)

Course Coordinator



Prof. Santosh Kumar Sahu

Professor, Department of Mechanical Engineering
Indian Institute of Technology Indore
(<http://people.iiti.ac.in/~santosh/>)

Department of Mechanical Engineering
Indian Institute of Technology, Indore
Khandwa road, Simrol, Indore-453552
Madhya Pradesh

Course Overview

This course aims to introduce fuel cell systems and its engineering aspects. The course covers basic principles of operation, efficiency and losses, types of fuel cells, fuel cell components, fuel for fuel cell, fuel cell system design, applications, and codes and standard. This course is for anyone designing, using, operating, and/or maintaining fuel cells. The hydrogen fuel cell introductory course is suitable for engineers and technicians working in or entering the fuel cell industry. It is also suitable for employees of industries that have recently invested or plan to invest in fuel cell technology.

Course Objectives

- To provide fundamental understanding of theory, analysis, performance, design and operation principles of various fuel cell components and systems and fuel processing.
- To understand the current state of technology of stationary and automotive fuel cell systems and components, and the challenges the industry faces today.
- Learn and perform qualitative analysis and quantitative calculations based on engineering and physical principles.
- Enhance problem solving skills and sharpen written communication skills through short technical report.

Learning Outcomes

- Students will learn various aspects of fuel cell starting from the definition of fuel cell, types of fuel cells, principle of operation, and applications.
- The course offers a balance of theoretical understanding, technical training.
- Exposure to fuel cell simulations in MATLAB/SIMULINK.
- Student will be able to model fuel cell system and predict its performances.

Course Syllabus

1. Introduction to Fuel Cells

(Introduction/History of Fuel Cells, basic Electrochemical concepts, definitions, principles of Electrochemical energy, conversion, fuel cell types, bipolar plates and cell stacks, fuel cell characteristics, advantages, disadvantages and applications)

2. Fuel Cell Performance

(Emf of the hydrogen fuel cell, efficiency and fuel cell voltage, cell efficiency, Gibb's free energy and ideal performance, cell energy balance, effect of pressure & gas concentration, the Nernst equation, system pressure and hydrogen, partial pressure, fuel cell irreversibility, activation losses, Tafel equation, fuel crossover, ohmic losses, the charge double layer, fuel cell equations)

3. Fuel Cell Types

(Alkaline Electrolyte Fuel Cell (AFC), Proton Exchange Membrane Fuel Cell (PEMC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel Cells (SOFC))

4. Stack Engineering

(Basic considerations: bipolar, common gas, geometry, materials, flow field plate design: parallel, serpentine, inter-digitated, fuel cell systems, fuelling fuel cell, fuel cell safety, codes and standards for fuel cell system)

Target Audience and Event type

- **Prerequisite:** Knowledge of word processing and spreadsheet software will be necessary for report preparation and some homework assignments. Knowledge of a computer programming language may also be helpful for some assignments.
- 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/), Post-Doc fellows and Faculty from reputed academic institutions and technical institutions.
- Lectures will be delivered through offline; participants are requested to attend through offline mode only.

Study Material and Certificate

Fuel Cells-Principles, Design, and Analysis, Shripad Revankar and Pradip Majumdar, CRC Press, ISBN978-1-42-008968-4, June 2014. Additional material will be provided for class lectures. Participation certificate will be given to all the participants.

Registration Fees

Category	Registration fees	Amount to be paid
Students and Researchers (UG/PG/PhD/Post-doc. JRF/SRF)	INR 6000 +18% GST	INR 7080/-
Faculty members	INR 10000 +18% GST	INR 11800/-
Engineers/Scientists from Industry, R&D organizations	INR 20000 +18% GST	INR 23600/-

Registration fees includes the lunch for each day of the event and the complete course material provided during the course.

Registration/Important Dates/Venue

- [Click here](#) to pay the fees and fill the registration form.
- Last date of receiving application: October 20, 2023.
- Intimation to the participants: October 22, 2023
- Course duration: November 2-4, 2023
- Venue: IIT Indore

Accommodation

Accommodation for the candidates can be provided inside the campus on **per night** chargeable basis. The accommodation charge will be INR 1000 + 12% GST for Centrally Funded Technical Institute (CFTI) and 1200 + 12% GST for non CFTI guests. A good number of hotels/resorts are also located in Indore (25 km away from the campus).

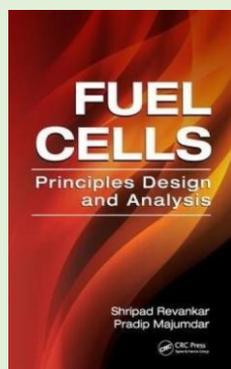
About Course Instructor

Professor Shripad Revankar

Dr. Revankar is a Professor of Nuclear Engineering and Director of Multiphase and Fuel Cell Research Laboratory in the School of Nuclear Engineering at Purdue University, West Lafayette, Indiana. He received his BS, MS, and Ph.D. all in Physics from Karnatak University, India and M.Eng. in Nuclear Engineering from McMaster University, Canada. He has worked as a post-doctoral researcher at Lawrence Berkeley Laboratory and at the Nuclear Engineering Department, University of California, Berkeley from 1984 to 1987. Then in August 1987 he joined School of Nuclear Engineering as a Visiting Assistant Professor. Since then, he has been serving SNE, currently as a professor. He also serves as BK21 Plus Visiting Professor in the Division of Advanced Nuclear Engineering at Pohang University of Science and Technology (POSTECH), South Korea. He has over 35 years (post Ph.D.) of research experience in advanced reactor systems, reactor safety, reactor thermal hydraulics, composite fuel for advanced nuclear reactors, instrumentation, multi-phase flow and heat transfer, microgravity multiphase flow, direct

energy conversion, hybrid power systems, nuclear hydrogen generation, solar energy storage, packed bed reactor, renewable energy, and fuel cell technology. He has published over 375 peer reviewed technical articles in archival scientific journals and conference proceedings and author/coauthor of three recent books: *Advances in Nuclear Fuels*, InTech publisher 2012, *Fuel Cells-Principles, Design, and Analysis*, CRC Press 2014, and *Storage and Hybridization of Nuclear Energy: Techno-economic Integration of Renewable and Nuclear Energy*, Academic Press, recently published in November 2018. He has chaired 25 MS thesis, 12 PhD thesis and has served on 90 MS and PhD thesis committees. He has mentored over 35 visiting scholar and post-doctoral researchers. He has presented over 110 invited seminars. He has served as research and educational consultant to academia, national laboratories and industries in Canada, China, Hong Kong, India, South Korea, and USA. He is Chief Editor of *Frontier in Energy- Nuclear Energy* and Chief Editor of *International Journal of Magnetism & Nuclear Science* He is also on editorial boards of other six international journals including *Heat Transfer Engineering*, *Journal of Thermodynamics, Nuclear Engineering and Technology*, and has served as Guest editor for *Nuclear Engineering and Design*.

He is Life Member of American Nuclear Society (ANS), American Society of Mechanical Engineer (ASME), American Institute of Chemical Engineers (AIChE), Korean Nuclear Society, (KNS), and Indian Society for Heat and Mass Transfer (ISHMT). He is also member of American Society for Engineering Education (ASEE), Electro Chemical Society (ECS) and American Association for Advancement of Science (AAAS). He was Chair of Thermal Hydraulics Division of ANS in 2007-08, Chair of ASME K-13 Committee on Heat Transfer in Multiphase Systems in 2009-11, Executive Member of the AIChE Transport and Energy Processes Division in 2006-2009, and Chair of the ASEE Nuclear and Radiological Division in 2008-2009.



(Widely adopted book on fuel cells: *Fuel Cells-Principles, Design, and Analysis*, Shripad Revankar and Pradip Majumdar, CRC Press, ISBN978-1-42-008968-4, June 2014)

He is Currently Vice Chair and Chair Elect Nuclear Engineering Division of ASME. He was elected as Fellow of ASME in 2008, Fellow of ANS in 2015 and Fellow of AIChE in 2017. He received Technical Achievement Award from American Nuclear Society Thermal Hydraulics Division in 2019 for his significant contributions to reactor thermal hydraulics through experiments, and for the modelling of phenomena important in the analysis of nuclear reactor safety and applications. He received ICONE Award in 2022 for his long-term contributions to nuclear technology and service jointly awarded by ASME, Japan Society of Mechanical Engineer (JSME), and Chinese Nuclear Society (CNS).

About Course Coordinator

Prof. Santosh Kumar Sahu

Dr. Sahu is a Professor of the Department of Mechanical Engineering at Indian Institute of Technology (IIT) Indore. He received his PhD from Indian Institute of Technology Kharagpur in 2009 and joined IIT Indore in October 2009 as an Assistant Professor; since then, he has been serving at Department of Mechanical Engineering, currently as a professor. He has been a visiting scholar and visiting researcher at Purdue University, USA during 2011 and 2019, respectively. Prior to this, he served as an Assistant Professor in the Department of Mechanical Engineering at National Institute of Technology (NIT) Rourkela.

Dr. Sahu's research group is actively engaged in the development of cutting-edge research to cater the cooling needs of next generation high performance thermal systems. His research group works on various areas including rewetting of hot surfaces, quenching of hot stationary, and moving surfaces, heat transfer enhancement with nanofluids, heat transfer behaviour of gaseous flows in micro devices, pool boiling heat transfer, impinging jets, synthetic jets, heat exchanging equipment, phase change materials and thermal management of electronics. Dr. Sahu has published over 185 articles in international journals and international conference proceedings, 7 book chapters and four patents. He has supervised 10 PhD students, 3 masters students, one post-doctoral fellow and supervising 6 PhD students. Dr. Sahu has received the prestigious IUSSTF Research Fellowship by Indo-US Science and Technology Forum for Engineering Sciences in 2011. He has served technical programme committee of numerous conferences and is a reviewer of various international journals. He is life member of the ISHMT and member of the ASME.

Contact Details

- Mr. Arun Kumar Bhagwaniya
Email: akb@iiti.ac.in, Mobile/WhatsApp: 7354583215
- Dr. Santosh Kumar Sahu
Email: sksahu@iiti.ac.in