



Course Brochure

Global Initiative of Academic Networks (GIAN)
International GIAN Course – 2024



on

PV-Fuel Cell Microgrid: A Sustainable Energy Solution (PVFCMGSES-2024)

December 26-31, 2024

Organized by



Department of Electrical Engineering
National Institute of Technology Rourkela,
Rourkela, India-769008

Course Coordinator(s):

Dr. Indrajit Sarkar : Course Coordinator

Dr. Monalisa Pattnaik : Course Coordinator

Prof. Shishir Kumar Sahu : Local GIAN Coordinator

PV-Fuel Cell Microgrid: A Sustainable Energy Solution (PVFCMGSES-2024)

Overview

In the last few decades, microgrid architecture has emerged as a typical smart grid framework and hence is receiving considerable attention from researchers from around the globe. Meanwhile, apart from several renewable energy sources, the fuel cell (FC) technology has also proven to be one promising clean electrical power source and has drawn significant attention from both the industry and academia over the past decade. Some encouraging achievements in FC technology such as clean and efficient energy sources, making the FC popular in the energy sector and is gaining penetration into the different fields of applications. One of the prominent applications of microgrids and FC is integrating FC with the microgrid along with the solar photovoltaic (PV) and hybrid energy storage system (HESS) with significant advancement in the microgrid performance with the use of hydrogen energy. However, such configurations with integrated FC, PV and HESS have several control and power management challenges. The key challenges could be from FC, PV, HESS, microgrid, and the control of the integrating interfaces. One key challenge with HESS integration is the control of the bi-directional converters for the controlled charging and discharging of the battery and the ultracapacitor in accordance with SOC of both. Moreover, two major challenges in the implementation and integration of HESS are SOC estimation and power delivery. On the other hand, when PV and FC are interfaced with a microgrid, both must deliver power to the microgrid at MPP, which is to be implemented individually due to their distinct characteristics. In the present scenario, there is constant thrust in the area of implementing hybrid energy storage system using solar PV and fuel-cell for microgrid applications. Furthermore, the need for energy management scheme to control the distributed generations, the power management and the power quality issues in islanded and grid interactive modes. Therefore, the idea of the course is a step towards the design and development of a PV-fuel cell microgrid allowing a quicker uptake to achieve a sustainable energy solution.

Objectives

The primary objectives of the course are as follows:

1. To develop a comprehensive understanding on state of art microgrid technologies with integrated distributed energy resources (DERs) and hybrid energy storage system (HESS)
2. To study various maximum power point tracking (MPPT) techniques of PV, Fuel cell systems
3. To discuss recent technologies related to power management and control techniques of microgrid
4. Improving the capability of the participants to select, size, and operate the HESS and DERs
5. Hands-on training in the design and development of different converters for microgrid application

Teaching Faculty

1. **Prof. Ramesh Bansal** - Professor with the Department of Electrical Engineering, University of Sharjah, and an Extraordinary Professor with the University of Pretoria (UP), South Africa.
2. **Dr. Indrajit Sarkar** - Assistant Professor, Department of Electrical Engineering, NIT Rourkela
3. **Dr. Monalisa Pattnaik** - Associate Professor, Department of Electrical Engineering, NIT Rourkela

Lecture Schedule: December 26-31, 2024

The course is divided into lectures, tutorials, simulation and hands-on modules as follows:

A. 28 Lectures of 30 mins each with following brief details:

Lecture 1,2: Introduction to microgrid concept and architectures

Lecture 3, 4: Integration of renewable energy (RE) systems and power electronic converters for microgrid

Lecture 5, 6: Control techniques and inverter control in microgrid

Lecture 7, 8: Microgrid system modeling part-1 and part-2

Lecture 9, 10: Microgrid system design and hybrid energy storage systems for microgrid

Lecture 11, 12: Energy management of microgrid system part-1 and part-2

Lecture 13, 14: Stability concerns in microgrid operations and technical challenges in microgrid

Lecture 15, 16: Microgrid control in islanded mode of operation and grid-connected systems: interfacing with the utility

Lecture 17, 18: Solar resource, insolation on a collecting surface, tracking systems part-1 and part-2

Lecture 19, 20: Photovoltaic system modelling and impact of the PV, I-V curve under standard test conditions (STC)

Lecture 21, 22: Impacts of temperature, insolation, and shading on I-V Curves; maximum power point trackers and

Lecture 23, 24: Stand-alone PV systems: estimating the load, battery storage sizing and optimal sizing of RES in MG application and capacity factors for PV grid-connected systems and its economics

Lecture 25, 26: Hierarchical control scheme in DC microgrid and application of microgrid in EV charging system

Lecture 27, 28: Power management of PV battery-SC HESS based microgrid part-1 and part-2

B. 8 Tutorials/hands on training of 1 hour each with following brief details:

Tutorial 1, 2: Design of power converters for solar PV system and hands-on of solar PV MPPT algorithms

Tutorial 3, 4: Introduction to fuel-cell and hands-on of fuel-cell MPPT algorithm

Tutorial 5, 6: Sizing analysis of PV-Fuel-cell based DC microgrid and simulation studies on DC microgrid

Tutorial 7, 8: Battery-SC based HESS control implementation and hands-on with C2000 DSP microcontroller

Evaluation

Participants will be evaluated through Assignments/Quiz. After successful completion of the course, all participants will get participation certificate. GIAN course details are available in national GIAN portal (<https://gian.iith.ac.in/>).

Number of participants attending this course in-person will be limited to Forty (40)

Prospective Participants

- Students at all levels (BTech /MTech/PhD) and researchers, faculty members in all areas of Electrical Engineering, power and energy systems and applications
- Engineers from industries and R&D laboratories from all areas of engineering working on power and energy systems and applications.

Registration Process & Fees

First, the participants have to do the mandatory registration in the Google form link given below. After scrutiny of the registered participants, maximum 40 participants will be notified through email for the registration fee payment. The registration fees (**non-refundable**) for participating in the course are as follows:

Category	Registration Fee (Excluding GST)
Students (Research Scholars/ PG / UG (3rd year onwards))	: INR 1000/-
Faculty/Researchers from Academic/Research Institutions	: INR 2000/-
Participants from Industry	: INR 5000/-
Participants from abroad	: USD 300/-

Registration fee for students / staffs of NIT Rourkela is nil.

Registration fee (*after receiving email confirmation*) can be directly deposited to **Account No: 10138951784, Account Name: CONTINUING EDUCATION NIT ROURKELA, IFSC No: SBIN0002109**, Branch: State Bank of India, NIT Campus Rourkela.

Online Registration Form (for external participants): <https://forms.gle/vWFotW6hUGXix4uQ6>

No TA, DA will be provided to the participants. Participants have to arrange their own accommodation and food. However, limited shared accommodation may be made available (subject to availability) in the Institute Guesthouse/ Guest Rooms of Hostels on request on first come first serve basis. Payment for accommodation & food is extra as per actuals.

Last Date of Registration: December 10, 2024

About the Institute:

National Institute of Technology Rourkela (NITR) has a diversified academic program with 17 academic departments offering specialized courses at undergraduate, postgraduate and doctoral levels of studies. The Institute currently offers 21 undergraduate programs in the major disciplines of engineering, architecture, science, humanities and management, and post graduate programs in diversified fields of research areas. While the academic programs offered by NIT Rourkela are in tune with the National Education Policy, the quality of education is continuously upgraded by periodical revision of syllabi based on the needs of industry and academia. With different inclusive initiatives and the introduction of a standardized education policy, over the years, the Institute's graduates have been great performers at professional fronts in India and abroad. With the focus on teaching and learning across departmental boundaries, the mix-technology and management skills, NITians have been valuable assets to our country. Today, NIT Rourkela is a highly prestigious institute with a reputation for excellence in research, consultancy and education at undergraduate, postgraduate and doctoral levels. It is passionately committed to making our country a world leader in technology and science and to inculcate this commitment among all its students. Our target is to be known around the world for our academic standards and to be counted among the best technological institutes of India in terms of innovation, entrepreneurship and creation of intellectual wealth.

Please visit: <https://www.nitrkl.ac.in/>

37 NIRF Overall	16 NIRF Engg.	29 NIRF Research	281-290 QS Asia
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About the Department

The course will be organized by the Department of Electrical Engineering, NIT Rourkela. The department of Electrical Engineering is established with the vision to design technologies and nurture technologists for diverse and sustainable growth in electrical engineering, leading to wealth and welfare of humanity. The department offers various UG, PG and PhD programmes with the mission to develop a platform for forging students as technocrats in line with cutting-edge academic, research and modern industrial practices, and enhancing their aptness in any technical sectors across the globe. **Please visit:** <https://website.nitrkl.ac.in/EE/>

How to reach NIT Rourkela

The Institute is located at about 7 km from the Rourkela railway station. Autos/taxis are available round the clock there. Local transport facility is also available from nearby private bus terminus. Official guests are normally received at the railway station. The Howrah-Mumbai line and Ranchi-Bhubaneswar line passes through this city. Major airports in the proximity of Rourkela are Jharsuguda, Ranchi, and Bhubaneswar.

Brief CV of Experts



Prof. Ramesh C. Bansal has more than 25 years of diversified experience of research, scholarship of teaching and learning, accreditation, industrial, and academic leadership in several countries. He is currently a Professor with the Department of Electrical Engineering, University of Sharjah, and an Extraordinary Professor with the University of Pretoria (UP), South Africa. Previously, he was a Professor and the Group Head (Power) with the ECE Department, UP. Prior to his appointment at UP, he was employed with the University of Queensland, Australia; University of the South Pacific, Fiji; BITS Pilani, India; and Civil Construction Wing, All India Radio. He has significant experience of collaborating with industry and Government organizations. These utilities include NTPC (a 60 GW Indian Power Generation Company), Powerlink, and ESKOM. He has made significant contribution to the development and delivery of B.S. and M.E. programs for utilities. He has extensive experience in the design and delivery of CPD programs for professional engineers. He has carried out research and consultancy and attracted significant funding from Industry and Government Organizations. He has published over 450 journal articles, presented papers at conferences, books, and chapters in books. He has Google citations of over 20000 and H-index of 67. He has supervised 25 Ph.D., four postdoctorals, and current supervising five Ph.D. students. His research interests include renewable energy (wind, PV, microgrid), power systems, and smart grid. He is a fellow of IET, U.K., and the Institution of Engineers, India.



Dr. Indrajit Sarkar received his Ph.D. degree in Electrical Engineering from IIT Bombay in 2018. He has nearly 7 years of industrial experience working in the area of power electronic converters are control. His areas of research interest are EV battery charging systems, grid-connected solar converters, DAB and TAB isolated DC/DC converters, multilevel converters, control of power converters etc. He completed his B.E. in Electrical Engineering and M.E. in power electronics and drives specialization from IEST Shibpur in 2005 and 2012 respectively. From Aug 2005 - Jun 2010, he served as an engineering graduate in ITES in the Energy and Utility vertical at Tata Consultancy Services Ltd., Kolkata. From 2012 to 2017, he was a full-time Research Scholar at the Department of Electrical Engineering, IIT Bombay. From 2017-2019, he has served as R&D Engineer in HVDC Grid System at ABB Global Industries Service Ltd., India. In July 2019 he joined as an assistant professor in the Department of Electrical Engineering MNIT Allahabad. Dr. Sarkar joined the Department of Electrical Engineering of NIT Rourkela in March 2020, where he is currently serving as Assistant Professor.



Prof. Monalisa Pattnaik received her B.Tech. degree in Electrical Engineering from the College of Engineering and Technology, Orissa University of Agriculture and Technology, Bhubaneswar, India, in 1999. She received her M.Tech. and Ph.D. degree from Indian Institute of Technology Kharagpur, India, in 2006 and 2013 respectively. Dr. Pattnaik is a recipient of the POSOCO Power System Award, Power Grid Corporation of India Ltd., India, in 2013. She joined as an Assistant Professor in the Department of Electrical Engineering, National Institute of Technology Rourkela in 2012 and is currently serving as an Associate Professor. Her prime areas of teaching and research include Wind and Solar Energy System, Hybrid Electric Vehicle, Efficient Power Management of Hybrid Energy Systems, Grid Integration issues of RES, Machine Drives and Power Electronics. Dr. Pattnaik has published 18 journals, 30 conference papers, and 5 book chapters excluding the publication during her PhD.

Contact Details:

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