Book of Abstract

NE-IECCE 2025

In a Glance

IEEE North East India International Energy Conversion Conference and Exhibition 2025

04 -06 JULY 2025

Organizing By

IEEE IAS Joint Chapter, Silchar Subsection in collaboration with Electrical Engineering Department NIT Silchar

IEEE IAS Joint Chapter Silchar

IEEE NE-IECCE 2025

Advancing Technology for Humanity

IEEE NE-IECCE 2025

North East India International Energy Conversion Conference and Exhibition

NE-IECCE 2025

04 -06 JULY 2025

IEEE IAS Joint Chapter Silchar

Organizing By
IEEE IAS Joint Chapter, Silchar Subsection in collaboration with Electrical Engineering Department NIT Silchar

FOREWORD

IEEE NE-IECCE 2025, The flagship Annual International Conference of IEEE Kolkata Section and Silchar Subsection Industry Applications Society Joint Chapter in association with the Department of Electrical Engineering, aims to provide a unique platform to researchers, practitioners, industry delegates, technocrats, and policymakers from academia and industry to share and promote recent research accomplishments and innovations for the sustainable development of industry and society. To cater to the future industry demands of Sustainable Energy Conversion and Transport Electrification, this conference aims to put forth the experts working in this area to share their research findings, which significantly impact modern smart grid, sustainable electric transportation and control.

TABLE OF CONTENTS

ORGANIZING COMMITTEE

Chief Patrons

Prof. Dilip Kumar Baidya
Director, NIT Silchar, India

Prof. Suparna Kar Chowdhury
Chair, IEEE Kolkata Section, India

Patrons

Prof. N. Sinha
Professor, NIT Silchar, India

Prof. F. A. Talukdar
Immediate Past Chair, IEEE Silchar Subsection, India

Prof. B. K. Roy
Chair, IEEE Silchar Subsection, India

Honorary General Chairs

Prof. Andy Knight
President, IEEE Industry Applications Society, USA

Prof. Aymal-El-Refaie
Marquette University, Milwaukee, USA

Prof. Akshay Kumar Rathore
Singapore Institute of Technology, Singapore

General Chairs

Dr. Vinod hadkikar
Khalifa University, UAE

Prof. A. K. Goswami
NIT Silchar, India

Prof. Kashem Muttaqi
UOW Australia, Australia

Organizing Chairs

Dr. Amritesh Kumar
NIT Silchar, India

Dr. Asha Rani M. A.
NIT Silchar, India

Organizing Secretary

Prof. L. C. Saikia
NIT Silchar, India

Dr. Avadh Pati
NIT Silchar, India

Dr. Biswarup Ganguly
NIT Silchar, India

Program Chairs

Prof. Bhim Singh
IIT Delhi, India

Prof. B. K. Panigrahi
IIT Delhi, India

Dr. Georgios Konstantinou
UNSW Sydney, Australia

Prof. S. Venugopal
Director, NIT Nagaland, India

Prof. Narasimharaju B. L
NIT Warrangal, India

Prof. N. B. D. Choudhury
NIT Silchar, India

Prof. Saurabh Chaudhury
NIT Silchar, India

Dr. Sumit Pramanik
IIT Delhi, India

Dr. Rabiul Islam
UOW Australia, Australia

Dr. Chandan Kumar
IIT Guwahati, India

Students Award Chair

Prof. Akshay Kumar Rathore
SIT Singapore, Singapore

Prof. Avanish Tripathi
IIT Delhi, India

Dr. Dipti Saxena
MNIT Jaipur, India

Dr. Phaneendra Babu Bobba
GRIET Hyderabad, India

Plenary & Women in Engineering Chairs

Kalpana R
NIT Karnataka, Surathkal, India
Dhivya Sampath Kumar
SIT Singapore, Singapore

Dr. Pampa Sinha
KIIT, Bhubaneswar, India

Technical Program Chairs

Prof. Sujit K Biswas
Past Chair, IEEE IAS Kolkata Chapter, India
Dr. Kundan Kumar
NIT Manipur, India
Dr. Ashish Ranjan
NIT Manipur, India
Dr. Arvind Jain
NIT Agartala, India
Dr. Srinivas Bhaskar Karanki
IIT Bhubaneswar, India
Dr. Ramesh Kumar
NIT Mizoram, India
Dr. Rajen Pudur
NIT Arunachal Pradesh, India
Dr. Sanjoy Debbarma
NIT Meghalaya, India
Dr. Partha Kayal
NIT Silchar, India
Dr. Deepu Sarkar
NIT Nagaland, India

Prof. Chitralekha Mahanta
IIT Guwahati, India
Dr. Anurag Sharma
Newcastle Uni, UK
Dr. Shailendra Singh
NIT Agartala, India
Dr. Bikram Das
NIT Agartala, India
Prof. J. P. Mishra
NIT Silchar, India
Dr. Pradeep Kumar
NIT Sikkim, India
Dr. Radak Blange
NERIST Arunachal Pradesh, India
Dr. Anish Ahmad
Tezpur University, India
Dr. Vivekanandan S.
NIT Silchar, India

Publication Chairs

Dr. Jaison Mathew
Govt. Engg College, Trissur, India
Dr. Sreenu Sreekumar
NIT Silchar, India

Dr. Atanu Kundu
Vice-Chair, IEEE Kolkata Section, India

Industry Interaction and Sponsorship Chairs

Dr. Anagha Bhattacharya
NIT Mizoram, India
Dr. N. Adhikary
NIT Silchar, India

Dr. T. Malakar
NIT Silchar, India

Website Chairs

Dr. Ashish Paramane
NIT Silchar, India
Dr. Biswajit Sahoo
NIT Silchar, India

Dr. Srikanth Allamsetty
NIT Silchar, India

Publicity Chairs

Prof. Gayandhar Panda
NIT Meghalaya, India
Dr. Abanishwar Chakrabarti
NIT Agartala, India
Dr. R. Dey
NIT Silchar, India
Dr. Piyali Das

Dr. P. Chinnamuthu
NIT Nagaland, India
Dr. Aurobinda Panda
NIT Sikkim, India
Dr. Anmol Ratna Saxena
NIT Delhi, India
Dr. Pukhrambam Devachandra Singh

NERIST, India
Dr. Sreejith. S
NIT Silchar, India
Dr. Ambrish Devanshu
NIT Silchar, India

NERIST, India
Dr. Saheli Ray
NIT Silchar, India

Finance Chairs

Dr. Prasanta Roy
NIT Silchar, India

Dr. Debayan Sarkar
NIT Silchar, India

Special Sessions/Tutorial Chairs

Dr. Pabitra Kumar Biswas
NIT Mizoram, India
Dr. Jiwanjot Singh
NIT Hamirpur, India
Dr. Swapna M.
NIT Silchar, India

Dr. Sourav Mallick
NIT Sikkim, India
Dr. P. Padmagirisan
NIT Agartala, India
Dr. Mallikarjuna
NIT Silchar, India

Student Activity Chairs

Dr. B. Shakila
NIT Nagaland, India
Prof. Ratna Dahiya
NIT Kurukshetra, India
Dr. T. Pradhan
NIT Silchar, India

Dr. Sree Lakshmi Gundebommu
CVRCOE, Hyderabad, India
Dr. D. K. Raju
NIT Silchar, India

Hospitality & Travel Chairs

Dr. D. C. Das
NIT Silchar, India
Dr. C. Bhattacharjee
NIT Silchar, India

Dr. R. K. Biswas
NIT Silchar, India

International Advisory Committee

Prof. Akshay Kumar Rathore
Singapore Institute of Technology, Singapore
Prof. Frede Blaabjerg
Alborg University, Denmark
Prof. Subhashish Bhattacharya
North Carolina State University, USA
Prof. Kashem Muttaqi
UOW Australia, Australia
Dr. Vinod Khadkikar
Khalifa University, UAE
Dr. Rabiul Islam
UOW Australia, Australia

Prof. Ambrish Chandra
ETS, Montreal, Quebec, Canada
Prof. Prasad Enjeti
Texas A&M, USA
Prof. Tarlochan Sidhu
Ontario Tech University, Canada
Prof. Subhas Mukhopadhyay
Macquarie University, Australia
Dr. Vijay Sood
Ontario Tech University, Canada
Prof. Leposava Ristic
University in Belgrade, Serbia

National Advisory Committee

Prof. Ajoy Kumar Ray
IIT Kharagpur, India

Prof. Vivek Agarwal
IIT Bombay, India
Prof. B. G. Fernandes
IIT Bombay, India
Prof. Prerna Gaur

Prof. Bhim Singh
IIT Delhi, India

Prof. Sukumar Mishra
IIT Delhi, India
Prof. Kishore Chatterjee
IIT Bombay, India
Prof. Suryanarayana Dolla

NSUT Delhi, India
Prof. Chandan Chakraborty
IIT Kharagpur, India
Prof. Iti Saha Misra
Immediate Past Chair, IEEE Kolkata Section, India
Prof. L. M. Saini
NIT Kurukshetra, India
Dr. Sumit Pramanik
IIT Delhi, India
Dr. Gurunath Gurrala
IISc Bangalore, India
Dr. Pradyumn Chaturvedi
VNIT Nagpur, India
Prof. Ratna Dahiya
NIT Kurukshetra, India
Dr. Jaison Mathew
GEC Trissur, India
Prof. Dheeraj Joshi
DTU, India
Prof. F. A. Talukdar
Past Chair, IEEE Silchar Subsection, India
Prof. Saravana Ilango
NIT Tiruchirappalli, India
Dr. Suvendu Samanta
IIT Kanpur, India
Dr. V. Sandeep
NIT Andhra Pradesh, India
Dr. Kundan Kumar
NIT Manipur, India
Dr. K Biju
APJ Abdul Kalam Technological University
,Govt. of Kerala

IIT Bombay, India
Prof. Debabrata Das
Chair, IEEE India Council, India
Prof. Sathans
NIT Kurukshetra, India
Prof. C. Nagamani
NIT Tiruchirappalli, India
Dr. Zakir Rather
IIT Bombay, India
Prof. Rajesh Kumar
MNIT Jaipur, India
Dr. Dipti Saxena
MNIT Jaipur, India
Prof. Jagdish Kumar
PEC Chandigarh, India
Prof. Vishal Verma
DTU, India
Dr. Vineet Saini
DST, India
Prof. Sivaji Bandhyopadhyay
Jadavpur University, India
Dr. Taimoor Khan
NIT Silchar, India
Mr. Jitesh Choudhary
CDAC Silchar, India
Prof. Ardhendu Saha
NIT Agartala, India
Dr. Papia Ray
VSSUT, Burla, India

Welcome Message by Director
NIT Silchar

Prof. Dilip Kumar Baidya
Director
National Institute of Technology Silchar
Chief Patron, NE-IECCE 2025

I am extremely happy to know that Department of Electrical Engineering, NIT Silchar in association with the IEEE Kolkata Section and the Silchar Subsection, Industry Applications Society (IAS) Chapter is going to organise the 2025 IEEE North-East India International Energy Conversion Conference and Exhibition (NE-IECCE 2025). This landmark event marks the inaugural edition of what we aspire to establish as a flagship annual international conference in the domain of sustainable and intelligent energy systems. NE-IECCE 2025 brings together a vibrant confluence of academia, industry, and innovation. It is a moment of immense pride for NIT Silchar to host this pioneering platform that fosters cross-disciplinary exchange and global collaboration in energy research and technology.

This year's conference is centred on the pressing global agenda of transitioning toward a sustainable and electrified energy future. NE-IECCE 2025 addresses a broad spectrum of transformative topics, including Power conversion for transportation electrification and renewable energy integration, Modeling and control of energy-efficient drives across land, air, and sea, Smart and sustainable charging infrastructure for e-mobility, Energy management for smart grids and rural electrification, IoT, cybersecurity, and AI applications for energy efficiency, Automation and digital transformation in industrial energy systems etc. These focus areas reflect both the urgency and the opportunity to reimagine energy systems in a decarbonized and digitally connected world.

On behalf of NIT Silchar, I extend my heartfelt gratitude to all our keynote speakers, authors, reviewers, exhibitors, sponsors, and delegates whose contributions have made this international gathering possible. Your presence and participation are instrumental in making NE-IECCE 2025 not just an academic event, but a movement toward impactful, global energy solutions. Let us use this platform to ignite new ideas, form lasting partnerships, and drive collaborative research that goes beyond borders and disciplines. I wish each of you a fruitful, engaging, and inspiring conference experience.

Warm regards,

Prof. Dilip Kumar Baidya
Director, NIT Silchar
Chief Patron, NE-IECCE 2025

IEEE NE-IECCE 2025

Message by Chair
IEEE Silchar Subsection

Prof. Binoy Krishna Roy
Professor
Electrical Engineering
National Institute of Technology Silchar
Chair, IEEE Silchar Subsection

Welcome Message

I, on my behalf and on behalf of Chair, IEEE Silchar Subsection, extend a warm and heartfelt welcome to you all, successful authors, conference attendees, keynote speakers, tutorial speakers, representatives from technical and financial sponsors, committee members, volunteers, special invitees and all others to the IEEE North-East International Energy Conversion Conference and Exhibition (NE-IECCE 2025), organized by the Department of Electrical Engineering at NIT Silchar, Assam, India, under the technical sponsorships of IEEE IAS, IES, Kolkata Section, Silchar Subsection, and IAS Joint Chapter Silchar.

This prestigious international conference, the first of its kind in the North-East part of the Country, has six tracks and seven special tracks to cover a wide range of researchers and experts. This hybrid platform will benefit every participant, from students to practitioners, by enriching their knowledge, fostering new connections, and providing valuable insights to propel their work forward. I am confident that your active participation will help achieve the conference's goal of exchanging ideas across various contemporary research fields, all in the spirit of "Advancing Technology for Humanity" and accelerate to push boundaries by focusing on “what next” in technology and achieving the 17 Sustainable Development Goals (SDGs).

I wish the conference a great success.

With warm regards,

Prof. Binoy Krishna Roy
Chair, IEEE Silchar Subsection
Professor, Department of Electrical Engineering, NIT Silchar

IEEE-IECCE 2025

Message by Immediate Past Chair IEEE Silchar Subsection

Prof. Fazal A Talukdar
Professor(HAG)
Electronicsand Communication Engineering
National Institute of Technology Silchar
Immediate Past Chair, IEEE Silchar Subsection

It is with immense pride and warm appreciation that we welcome you to the inaugural edition of the 2025 IEEE North-East India International Energy Conversion Conference and Exhibition (NE-IECCE 2025).

Hosted at NIT Silchar, in association with the IEEE Kolkata Section and the Silchar Subsection IAS Chapter, this event represents a pivotal moment in our collective journey toward a sustainable and technologically advanced energy future.

NE-IECCE 2025 has been thoughtfully envisioned as a confluence of innovation, research, and real-world application. With topics spanning power electronics, intelligent energy systems, electric mobility, and inclusive electrification, this conference stands at the intersection of cutting-edge science and societal progress.

We extend our sincere gratitude to all those whose dedication and expertise have shaped this initiative—speakers, contributors, reviewers, volunteers, sponsors, and participants.

May this gathering inspire dialogue, discovery, and collaboration that extends far beyond these sessions—fostering progress for communities worldwide. Wishing you all a memorable stay at NIT Silchar during these three days of the conference.

Best wishes,

Prof. Fazal A Talukdar
Professor(HAG)
Electronics and Communication Engineering
National Institute of Technology Silchar
Immediate Past Chair, IEEE Silchar Subsection

NE-IECCE 2025

Message by Honorary General Chair NE-IECCE 2025

Prof. Akshay Kumar Rathore (IEEE Fellow)
Professor and Programme Leader
(Electrical Power Engineering)
Singapore Institute of Technology (SIT, Singapore
Honorary General Chair NE-IECCE 2025

Dear Participants and stakeholders,

It is with great pleasure that we welcome you all to the inaugural edition of the IEEE North-East India International Energy Conversion Conference and Exhibition (NE-IECCE 2025), a Flagship International Conference of the IEEE Industry Applications Society what we envision as a prestigious annual global platform for innovation in energy conversion. Jointly organized by the IEEE Kolkata Section and Silchar Subsection Industry Applications Society Chapter, in collaboration with the Department of Electrical Engineering, NIT Silchar, this conference marks a significant milestone in our collective pursuit of innovation and sustainability in energy conversion. The conference will rotate among the naturally beautiful north-east states of India.

NE-IECCE 2025 is dedicated to advancing power conversion technologies and intelligent energy strategies aimed at creating a sustainable, electrified future. This platform brings together a diverse global community of researchers, engineers, academicians, industry experts, and thought leaders to discuss cutting-edge developments across a wide range of topics, including Transportation electrification and smart energy systems, Energy-efficient drive control for land, air, and marine mobility, Charging infrastructure for e-mobility, Rural electrification and smart grid innovations, IoT, cybersecurity, and AI for energy optimization, Automation and digitization for industrial energy systems. The interactions and discussions with eminent experts in the area of Power, Energy and Control during these three days not only bring forth the challenges but immense opportunities to reshape the global energy landscape.

We sincerely thank all Keynote, Tutorial, SYP and WIE speakers, authors, reviewers, sponsors, exhibitors, and participants whose efforts and enthusiasm have brought this event to life. Your participation and passion are the driving force behind the success of NE-IECCE 2025.

May this conference serve as a powerful platform for knowledge exchange, innovation, and long-lasting partnerships that transcend borders and disciplines.

Warm regards,

Akshay Kumar Rathore IEEE Fellow
Professor and Programme Leader (Electrical Power Engineering)
Singapore Institute of Technology (SIT), Singapore
Honorary General Chair IEEE NE-IECCE 2025

IEEE NE-IECCE 2025

Message of Head of Department Electrcial Engineereing

Dr. Tanmoy Malakar
Head of the Department
Electrical Engineering Department
National Institute of Technology Silchar

I on behalf of Electrical Engineering Department, NIT Silchar take this opportunity to welcome all the participating authors, distinguished keynote speakers, industry delegates and others in this flagship Annual IEEE North-East International Energy Conversion Conference and Exhibition (NE-IECCE 2025) scheduled to be held during 4-6th July 2025 at NIT Silchar. It gives me immense pleasure to extend my heartfelt gratitude to our technical sponsors IEEE IAS, IES, Kolkata Section, Silchar Subsection, and IAS Joint Chapter Silchar for their immense support.

I would like to congratulate every member of the organizing committee for accepting this challenge and confident that the efforts that has been put together will make the event a successful and memorable one.

Under the Act East policy, when a significant and transformative development have been taking place in the North-Eastern region of India in terms of connectivity, trade, healthcare, tourism and energy sector, this conference is a 1st of its kind planned at NIT Silchar with an aim to provide a common platform for researchers, academicians, industry practitioners, policy makers and innovators from all over India and abroad to share their ideas on sustainable developments related to Energy Conversion and smart Mobility. I strongly believe that with our efforts and your active participation, we will be able to find path in the direction of sustainable development for North Eastern region.

I am happy to inform you that we have received a large volume of papers and only about 30% are accepted for presentation. This itself speaks about the quality of the selected papers.

I hope our volunteers and members will look after your stay, food and travel enthusiastically.

I extend my sincere thanks to all our sponsors, reviewers, committee members for their support and wish a grand success of this conference.

Jai Hind

Dr. Tanmoy Malakar
Head of the Department
Electrical Engineering Department
National Institute of Technology Silchar

Message of General Chair
NE-IECCE 2025

Prof. Vinod Khadkikar
Professor,
Khalifa University, UAE
IEEE IAS Representative
Genreral Chair NE-IECCE 2025

Dear Participants of NE-IECCE 2025,

It is with great pleasure that we welcome you all to the 2025 IEEE North-East India International Energy Conversion Conference and Exhibition (NE-IECCE 2025). This landmark event marks the inaugural edition of what we envision as a flagship annual international conference, jointly organized by the IEEE Kolkata Section & Silchar Subsection Industry Applications Society Chapter, in association with the Department of Electrical Engineering, NIT Silchar, Assam, India.

As we come together at this dynamic intersection of academia, industry, and innovation, we are reminded of our shared responsibility to lead the transition toward a more sustainable, electrified global energy future.

IEEE NE-IECCE 2025 places a strong focus on power conversion technologies and strategies aimed at achieving a sustainable and electrified future, highlighting cutting-edge systems, emerging solutions, and intelligent innovations that will define the next generation of energy systems. We are honored to host a distinguished and diverse community of researchers, engineers, industry professionals, and thought leaders from across the globe, all sharing a common commitment to developing impactful and sustainable energy solutions.

The conference addresses a wide range of pivotal and emerging topics pertaining to transportation electrification and sustainable energy integration; energy efficient drives for electric transportation (land, air and sea); smart and sustainable charging infrastructure for e-mobility; and digital control techniques for industrial applications.

These areas reflect the urgency and the tremendous opportunity to reimagine how energy is produced, managed, and utilized in a decarbonized and digitally connected world.

- We extend our sincere gratitude to our keynote speakers, authors, reviewers, exhibitors, sponsors, and participants. Your valuable contributions and enthusiastic participation are what make this conference truly meaningful. We hope IEEE NE-IECCE 2025 becomes a platform not only for the exchange of ideas but also for fostering long-term collaborations that transcend boundaries.

Warm Regards,

Prof. Vinod Khadkikar
General Chair
NE-IECCE 2025

Message of General Chair
NE-IECCE 2025

Prof. Arup Kumar Goswami
Professor,
Electrical engineering Department
National Institute of Technology Silchar
General Chair NE-IECCE 2025

Dear Participants,

Welcome to the inaugural IEEE North-East India International Energy Conversion Conference and Exhibition (NE-IECCE 2025), jointly organized by the IEEE Kolkata Section, IEEE IAS Chapter of Silchar Subsection, and the Department of Electrical Engineering, NIT Silchar. As General Chair, I am delighted to host this pioneering event, which aims to foster innovation and collaboration in the field of sustainable energy.

NE-IECCE 2025 provides a vibrant platform to explore advanced energy conversion technologies, electric mobility and its infrastructure, intelligent digital tools for reliable and equitable power systems, and inclusive solutions for rural electrification.

We are deeply grateful to our keynote speakers, contributing researchers, industry partners, and participants whose enthusiastic support has shaped this event.

Let us seize this opportunity to exchange knowledge, spark new ideas, and forge meaningful collaborations that will drive us toward a cleaner, smarter, and more sustainable energy future.

Warm wishes,

Prof. Arup Kumar Goswami
General Chair
NE-IECCE 2025

Message of Organizing Chair
NE-IECCE 2025

Dr. Ahsa Rani M. A.
Assistant Professor,
Electrical engineering Department
National Institute of Technology Silchar
Organizing Chair NE-IECCE 2025

Dear Participants and Delegates,

It is with immense pride and warm appreciation that we welcome you to the inaugural edition of the 2025 IEEE North-East India International Energy Conversion Conference and Exhibition (NE-IECCE 2025).

Organized at NIT Silchar in collaboration with the IEEE Kolkata Section and the Silchar Subsection IAS Chapter, this event marks a significant milestone for the region and for all of us committed to a sustainable energy future in bringing together leaders in energy systems, conversion technologies, and sustainable innovation.

Our vision for NE-IECCE 2025 was to create more than just a conference, it is a dynamic platform where cutting-edge ideas meet practical solutions. The themes we explore, from power electronics and smart energy systems to electric mobility and rural electrification, are not just about innovation, they're about making real-world impact. This conference represents a vital step forward in aligning academic research with real-world applications, especially at a time when our global community faces critical energy and environmental challenges. With a strong focus on power conversion strategies for electrified and sustainable systems, NE-IECCE 2025 provides a unique platform for knowledge exchange, interdisciplinary engagement, and solution-driven dialogue.

We applaud the efforts of the entire NE-IECCE team, technical contributors, and participating delegates who have made this event possible. Your commitment to excellence and innovation ensures that this conference will not only address current challenges but also spark new partnerships, long-lasting collaborations, and fresh ideas for impactful advancements.

Dr. Asha Rani M. A.
Organizing Chair
NE-IECCE 2025

Message of Organizing Chair
NE-IECCE 2025

Dr. Amritesh Kumar
Assistant Professor,
Electrical engineering Department
National Institute of Technology Silchar
Organizing Chair NE-IECCE 2025

Dear Participants and Delegates,

A very warm welcome to the first edition of NE-IECCE 2025—a conference created to ignite innovation, foster collaboration, and accelerate our journey toward a sustainable energy future.

Hosted by NIT Silchar, in collaboration with the **Department of Electrical Engineering,** the **IEEE Kolkata Section,** and the Silchar Subsection IEEE IAS Chapter, this event brings together a vibrant community of researchers, industry experts, and aspiring leaders—united by a shared mission: to rethink how the world generates, distributes, and consumes energy.

As we navigate a global shift toward sustainable practices, NE-IECCE 2025 explores some of the most vital topics of our time. From smarter methods of energy conversion and advances in electric vehicles and charging infrastructure, to digital solutions for safer, fairer power systems and innovative strategies for rural electrification—this conference highlights the ideas and technologies shaping our future.

This event would not have been possible without the dedication and hard work of our incredible **volunteers**, alongside our speakers, paper authors, reviewers, and sponsors. Your passion, time, and tireless efforts are the backbone of NE-IECCE 2025. **Thank you** for bringing this vision to life.

We hope this first edition sparks new ideas, forges meaningful connections, and leaves a lasting impact.

Let's shape the energy future—together.

Warm regards,

Dr. Amritesh Kumar
Organizing Chair
NE-IECCE 2025

IEEE North East India International Energy Conversion Conference and Exhibition
NE-IECCE 2025
4-6 July 2025 | NIT Silchar, Assam, India

IEEE North-East India International Energy Conversion Conference and Exhibition (NE-IECCE) 2025

July 4-6, 2025

1st Flagship Conference of IEEE IAS Joint Chapter of IEEE Silchar Subsection | @ National Institute of Technology Silchar, Assam | India

Program Schedule @ a Glance (Indian Standard Time GMT+5:30)

Guest House Auditorium (GHA) / EE Dept. NIT Silchar/SAC Building

Time	Program	Venue
DAY 1 : 4th JULY 2025		
08.30 AM Onwards	IEEE NE-IECCE 2025 Registration	GHA Entrance

09.30 AM - 11.00 AM	**Tutorial 1** **Design and Engineering of High Power Converters** **Prof. Sujit K. Biswas** ***Former Professor, Jadavpur University***	**Guest House Auditorium**
11.00 AM - 11.15 AM	**Tea Break**	**Guest House First Floor**
11.15 AM - 12.45 PM	**Tutorial 2** **Power Architecture and Control of Indian Railway Traction Converter** **Dr. Avanish Tripathi** ***IIT Delhi***	**Guest House Auditorium**
12.45 PM - 01.45 PM	**Lunch Break**	**SAC Building** **(Near Central Library, NIT Silchar)**
01.45 PM - 03.00 PM	**Tutorial 3** **Interconnection and Interoperability of Distributed Energy Resources** **Dr. Sivaneasan Bala Krishnan** ***Deputy Director, SIT Teaching and Learning Academy***	**Guest House Auditorium**
03.00 PM - 03.15 PM	**Tea Break**	**Guest House First Floor**
03.15 PM - 04.30 PM	**Tutorial 4** **Aerospace Electrification and Condition Monitoring** **Dr. Sivakumar Nadarajan** ***National University of Singapore***	**Guest House Auditorium**
04.30 PM - 05.30 PM	**IEEE IAS NE-IECCE Students Symposium** ***(Poster Presentation Session 1)*** **+ Networking High Tea**	**SAC Building** **(Near Central Library, NIT Silchar)**
05.30 PM Onwards	**Magic Show**	**SAC Building** **(Near Central Library, NIT Silchar)**
DAY 2 : 5th JULY 2025		
08.00 AM Onwards	**Break Fast**	**SAC Building** **(Near Central Library, NIT Silchar)**
09.00 AM – 10.30 AM	**Technical Session - 1**	**EE Department, NIT Silchar**
	Oral Presentation-1	**EED Seminar Hall**
	Oral Presentation-2	**CIA Classroom**
	Oral Presentation-3	**PESE Classroom**
	Oral Presentation-4	**CR-01**
	Oral Presentation-5	**Project Lab**
	Oral Presentation-6	**Maths Seminar Hall**
09.30 AM – 10.30 AM	**IEEE IAS NE-IECCE Students Symposium** ***(Poster Presentation Session 2)***	**SAC Building** **(Near Central Library, NIT Silchar)**

10.30 AM - 11.00 AM	**Tea Break**	**Guest House First Floor**
11.00 AM - 11.40 AM	**IEEE NE-IECCE 2025 Inauguration**	**Guest House Auditorium**
11.40 AM - 12.20 PM	**Keynote 1** **Power Supplies Design for Data Center Power System Stability** **Prof. Jian Sun** ***Rensselaer Polytechnic Institute & Director, New York State Center for Future Energy Systems (CFES)***	**Guest House Auditorium**
12.20 PM - 01.00 PM	**Keynote 2** **Interoperability of Grid-forming Controls for Inverter-based Resources** **Prof. Sairaj Dhople** ***University of Minnesota Minneapolis, USA***	**Guest House Auditorium**
01.00 PM - 02.00 PM	**Lunch Break**	**SAC Building** **(Near Central Library, NIT Silchar)**
02.00 PM – 02.40 PM	**Keynote 3** **Silicon and Wide Bandgap Power Semiconductors/ Modules for Power Conversion: Trends, New Technologies, and Challenges** **Dr. Gourab Majumdar** ***Mitsubishi Electric Corporation (Power Device Works)***	**Guest House Auditorium**
02.40 PM – 03.20 PM	**Keynote 4** **Technical Trends of Electric Motor and Drives for Industrial Applications** **Dr. Kouki Matsuse** ***Meiji University, Japan***	**Guest House Auditorium**
03.20 PM – 04.00 PM	**IEEE WIE Panel Discussion** ***EmpowerHER : Mentor, Network & Lead for Bridging Gaps to Empower Women to become NextGen Leaders in Technology***	**Guest House Auditorium**
04.00 PM – 04.15 PM	**Tea Break**	**Guest House First Floor**
04.15 PM – 05.15 PM	**IEEE IAS NE-IECCE Students Symposium** ***(Poster Presentation Session 3)***	**SAC Building** **(Near Central Library, NIT Silchar)**
04.30 PM – 6.00 PM	**Technical Session - 2**	**EE Department, NIT Silchar**
	Oral Presentation-7	**CR-01**
	Oral Presentation-8	**CR-02**
	Oral Presentation-9	**Project Lab**
	Oral Presentation-10A	**CIA Classroom**
	Oral Presentation-10B	**PESE Classroom**

	Oral Presentation-11	**EED Seminar Hall**
	Oral Presentation-12	**Maths Seminar Hall**
07.00 PM – 09.30 PM	**GALA DINNER** *(with Light Music)*	***Sagarika Resort, Silchar*** 
DAY 3 : 6th JULY 2025		
08.00 AM Onwards	**Break Fast**	**SAC Building** **(Near Central Library, NIT Silchar)**
09.00 AM – 09.40 AM	**Keynote 5** **ANN Based Wind and SPV Power Forecasting** **Prof. SN Singh** ***Director, IIIT Gwalior (Professor, IIT Kanpur)***	**Guest House Auditorium**
09.40 AM – 10.30 AM	**IEEE SYP Panel Discussion** ***Inspire & Ignite the Young Minds to be Tomorrow's Tech Leaders - IEEE Youth Perspectives***	**Guest House Auditorium**
10.30 AM – 11.00 AM	**Tea Break**	**Guest House First Floor**
11.00 AM – 12.00 PM	**IEEE IAS NE-IECCE Students Symposium** ***(Poster Presentation Session 4)***	**SAC Building** **(Near Central Library, NIT Silchar)**
11.00 AM – 01.00 PM	**Technical Session - 3**	**EE Department, NIT Silchar**
	Oral Presentation-13	**EED Seminar Hall**
	Oral Presentation-14	**CIA Classroom**
	Oral Presentation-15	**PESE Classroom**
	Oral Presentation-16	**CR-01**
	Oral Presentation-17	**Project Lab**
	Oral Presentation-18	**Maths Seminar Hall**
01.00 PM – 02.00 PM	**Lunch Break**	**SAC Building** **(Near Central Library, NIT Silchar)**
02.00 PM – 02.15 PM	***Industry Talk*** ***dSPACE India Solutions, Bangalore***	**EED Seminar Hall**
02.15 PM – 02.30 PM	***Industry Talk*** ***Entuple Technologies Pvt. Ltd., Bangalore***	**EED Seminar Hall**
03.00 PM – 04.00 PM	**Valedictory & Award Distribution**	**Guest House Auditorium**
04.00 PM Onwards	**Tea Break** + Nearby Tea Garden Visit	**GHA Entrance**

Co-Sponsors

MAVERICK dSPACE Promptech Instruments Tektronix SBI MUTUAL FUND SBI CDAC ENTUPLE TECHNOLOGIES Scientech

IEEE IAS NE-IECCE Oral Paper Presentation Schedule

DAY 2: 5th JULY 2025

Technical Session 1 (Oral Presentations: 1-6)

Oral Presentation-1 (EED Seminar Hall)

Special Session 1: Advances in Control and Operation of Inverter-Dominated Power Distribution System

Time: 09.00 AM – 10.30 AM

Session Chairs: Dr. Shailendra Kumar, Indian Institute of Technology Bhilai; Prof. Nidul Sinha, NIT Silchar

Paper Ids	Paper Title
369	Double Boosted voltage 5 Level Inverter Topology for Renewable Energy Applications
497	Impedance Based Stability Analysis of DC Microgrid
408	A Novel Backup Protection Function to Realize Dependable Numerical Protection
484	Logarithmic Absolute Square Error Based Differential Protection Scheme for AC Microgrid
374	A Hybrid MPPT Approach for BLDC Motor Speed Control Using Adaptive pi and Boost Converter
889	Flux Observer-Based Position Sensorless Control of PMaSyRM for Light Electric Vehicles with Regenerative Braking

Oral Presentation-2 (CIA Classroom)

Special Session 4: Stationary and Mobile battery storage for Advancing grid Resilience and flexibiliTy (SMART)

Time: 09.00 AM – 10.30 AM

Session Chairs: Dr. Subho Paul, IIT (BHU) Varanasi, Prof. L. C. Saikia, NIT Silchar

Paper Ids	Paper Title
457	DESIGN AND SIMULATION FOR A FULL BRIDGE LLC DC-DC CONVERTER FOR EV CHARGING APPLICATION
251	Grid-Forming Control for Edge-Based DERs: Integration Strategies and Performance in Weak Grids
376	Quantum Computing for Enhanced Material Discovery and Optimization in Electric Vehicle Batteries
436	A Novel Hybrid Islanding Detection Technique for PV-Battery DC Microgrid
456	BatteryRL: Deep Q-Network for Intelligent Battery Management in Smart Grid Environment
465	Peer-to-Peer Energy Trading Framework for Microgrid Community Considering Community Hybrid Energy Storage
693	Performance Comparison of Conventional and Three level Buck-Boost converter for Efficient EV Charging Application

Oral Presentation-3 (PESE Classroom)

Special Session 5: Artificial Intelligence and Machine Learning for Smart, Resilient, and Sustainable Energy Systems

Time: 09.00 AM – 10.30 AM

Session Chairs: Dr. Sreejith S., NIT Silchar; Dr. R. Dey, NIT Silchar

Paper Ids	Paper Title
275	Machine Learning-Based Backup Protection for Wind Farm Integrated Transmission System
479	Monitoring and Prognostics of Lithium-Ion Batteries Using Dual Gaussian Process Regression
529	A Novel Interturn Fault Identification Solution for BLDC Motor Based EV System
603	Enhanced Speed Control of Hybrid Energy Source-based Switched Reluctance Motor Employing PSO-Tuned PI Controller
725	A Machine Learning-Driven Oscillatory Mode Estimation Scheme for Smart and Sustainable Energy Systems Using Degraded PMU Measurements

Oral Presentation-4 (CR-01)

Special Session 6: Hydrogen Fuel Cells and Hybrid Electric Vehicles: Innovations in Control, Design, and Policy for Sustainable e-Mobility

Time: 09.00 AM – 10.30 AM

Session Chairs: Dr. Sukanta Halder, Indian Institute of Technology (ISM) Dhanbad; Dr. Mousam Ghosh, Walchand College of Engineering Sangli

Paper Ids	Paper Title
602	Eliminating Cascaded Control Loops: A Neural Network Approach for Grid-Forming Inverters
683	Ideal location for DG to advance their voltage profile using STATCOM and renewable vitality sources
719	Mitigation of DC Bus voltage Oscillations in Cascaded Systems of DC Microgrids: A Novel Source-Side Virtual RL Damper Approach

720	A Novel Source-Side Virtual RLC Damping Approach to Mitigate DC Bus Voltage Oscillations in Cascaded System of DC Microgrids
768	Hierarchical Attention-Enhanced Transformer Framework for Prognostic Degradation Modeling and Capacity Estimation of Lithium-Ion Batteries
771	Ultra-High Gain DC-DC Converter driven PMSM for Green Energy Application

Oral Presentation-5 (Project Lab)

Special Session 7: Advances in Wired and Wireless Charging Infrastructure for Sustainable Vehicular Technologies

Time: 09.00 AM – 10.30 AM

Session Chairs: Dr. Kundan Kumar, NIT Jamshedpur; Dr. Kumari Sarita, Government Engineering College Aurangabad, Bihar

Paper Ids	Paper Title
386	Parametric Analysis of Recent Hybrid BIPV Array Configurations for Power Loss Mitigation under Non-uniform Shading Situations
596	In-Motion Charging Coil configuration for the Improved Battery Charging of Electric Vehicles
614	Analysis of Coupled Inductor based Full Bridge Dual Active Bridge Isolated Converter for Electric Vehicle Charging
748	Analysis of SiC MOSFET-based Phase-shift and Quasi Square Wave Modulated Dual Active Bridge Converter for On-board Charging Application
802	Analysis of Four-switch Non-isolated Non-inverting Buck-Boost Converter Considering Non-idealities

Oral Presentation-6 (Maths Seminar Hall)

Track 1: Power Conversion Technologies for Transportation Electrification and Sustainable Energy Integration

Time: 09.00 AM – 10.30 AM

Session Chairs: Prof. Arup Kumar Goswami, NIT Silchar, Dr. B. Shakila, NIT Nagaland

Paper Ids	Paper Title
201	A Quarter Wave Symmetry Based Modified Harmonic Minimization Scheme for 3-Phase 7-Level Cascaded H-Bridge Multilevel Inverter
283	Centrally Aligned Pulse Based One Cycle Control Technique for PWM Voltage Source Inverters
359	Novel Single Switch Quadratic Boost Converter with Continuous Input and Common Ground
371	A Non-Isolated Voltage Lift based Enhanced Quadratic Boost Converter
373	A Novel Bridgeless Cuk-Cascaded Flyback PFC Converter for EV Charging
762	Stability Assessment of an IBR-based LFC System using Grid-Forming (GFM) Inverter Control

DAY 2: 5th JULY 2025

Technical Session 2 (Oral Presentations: 7-12)

Oral Presentation- 7 (CR 01)

Track 2: Modeling and Control of Energy Efficient Drives for Electric Transportation (LAND, AIR AND SEA)

Time: 04.30 PM – 6.00 PM

Session Chairs: Prof. Vinod Khadkikar, Khalifa University, UAE; Dr. Vijay Mohale, Walchand Collge of Engineering

Paper Ids	Paper Title
344	Development of the Dynamic Model of a Single-Stator Dual-Rotor Induction Machine
665	Efficient Sensorless Speed Control Techniques for BLDC Motors Using Back-EMF Zero-Crossing
307	An Uniform Wideband High-Frequency Current Transformer for Measurement of Partial Discharges in High Voltage Power Apparatus
309	Estimation of Inertial Transfer Function Coefficients and Algorithm Development for Forecasting Inertia in Indian National Electricity Grid
775	Analyzing the Performance of Linear and Nonlinear Multi-Period Optimal Power Flow Models for Active Distribution Networks

Oral Presentation-8 (CR 02)

Track 3: Smart and Sustainable Charging Infrastructure for e-Mobility

Time: 04.30 PM – 6.00 PM

Session Chairs: Dr. Arunima Dutta, NIT Meghalaya; Prof. Saurabh Chaudhury, NIT Silchar

Paper Ids	Paper Title
375	A High-Efficiency EV Charging System with Interleaved Buck-Boost Converter and Adaptive Control
490	Design and Simulation of EV Charger for wide Voltage range based on Phase shift full bridge DC-DC Converter
587	An IoT based Cloud Integrated State of Charge Estimation of battery Pack in SIMULINK Platform
908	Design and Analysis of Charging and Discharging System for Electric Two-Wheeler
430	Assessment of Seasonal Variability for Resilience and Reliability Analysis of Grid Integrated Photovoltaic Systems for Energy Management
432	MISMATCH CURRENT EXTRACTION TECHNIQUE USING MULTI INPUT SINGLE OUTPUT DC-DC CONVERTER TO ENHANCE THE PERFORMANCE OF THE PARTIALLY SHADED PHOTOVOLTAIC ARRAY.
613	Control and Modelling of PMSG-based Wind Turbine for integration to Conventional Grid

Oral Presentation-9 (Project Lab)

Track 5: Computational Intelligence, Cyber Security and IoT Applications for Energy Efficiency and Conservation

Time: 04.30 PM – 6.00 PM

Session Chairs: Prof. Nalin Behari Dev Choudhury, NIT Silchar; Dr. Nilesh Kumar Rajalwal, BITS Mesra

Paper Ids	Paper Title
464	An Enhanced Energy Conserving Sensor Scheduling Scheme for Wireless Sensor Networks
622	A Hybrid Deep Learning Network for Grid-Connected Solar Panel Fault Detection
714	FedCNN: Federated Learning Framework Based CNN Model for Fault Classification in IEEE 30 Bus Transmission System
773	Cyber-Induced Voltage Deviation Detection and Mitigation in DC Microgrids Under Operational Constraints
909	Harris Hawks Optimized Regulated Frequency in Thermal, Hydro, and Solar Integrated Power System
427	Design of Event-Based Sliding Mode Controller under Denial of Service Attack

Oral Presentation-10A (CIA Classroom)

Track 6: Automation, Control and Digitisation for Industry Applications

Time: 04.30 PM – 6.00 PM

Session Chairs: Dr. Piyush Pratap Singh, NIT Meghalaya; Dr. Anish Ahmad, Tezpur University

Paper Ids	Paper Title
135	Induction Motors with Variable Frequency Drives: A Systematic Review with Focus on Health Monitoring
297	Second-order Sliding Mode Load Frequency Control of Interconnected Power System
321	Review of Condition-based Monitoring Techniques for Electrical and Industrial Assets to Promote Digitalization Strategies for Utilities
385	A Novel Reaching Law-based Double Integral Sliding Mode Control for Automatic Voltage Regulator
702	A Direct Method to Improve the Load Margin of Power Systems
740	A Five-Stage Algorithm For Estimating Electromechanical Modes of Power Systems
856	Data-Driven Diagnostic Analysis of an Oil Leakage Incident in a Utility-Scale Distribution Transformer

Oral Presentation-10B (PESE Classroom)

Track 4: Energy Conversion and Management for Sustainable Smart Energy Systems and Rural Electrification

Time: 04.30 PM – 6.00 PM

Session Chairs: Dr. Sanjoy Debbarma, NIT Meghalaya; Dr. Avirup Maulik IIT (BHU) Varanasi

Paper Ids	Paper Title
358	Multi-layer Perceptron-Recurrent Neural Network VSC for EV Charging Stations with Integrated Renewable Energy Systems
451	BIPV Based Community Microgrid Aggregation for Net Zero Energy Building
452	Performance Analysis of Grid-Forming Converters in Battery Energy Storage Systems for Large-Scale Solar/Wind Integration
865	Enhanced Performance of Triboelectric Nanogenerator for Martian Environment
330	Direct method for evaluation of energy conversion efficiency in solenoid valves during start transient and improvements obtained by core annealing
834	Design and Analysis of TSK Fuzzy Controllers based Grid Connected DFIG System for Improving Power Quality
793	Digital Control System Based Isolated Totem Pole Converter for Electric Vehicle Onboard Chargers
876	Predictive Models for Voltage Degradation in PEM Fuel Cells Using Gradient Boosting and LSTM Networks
412	A Novel Adaptive Modulation Scheme for Reactive Power Minimization in Dual Active Bridge with Varying Load Demands

Oral Presentation-11 (EED Seminar Hall)

Track 5: Computational Intelligence, Cyber Security and IoT Applications for Energy Efficiency and Conservation

Time: 04.30 PM – 6.00 PM

Session Chairs: Dr. Nabanita Adhikary, NIT Silchar; Dr. B. Ganguly, NIT Silchar

Paper Ids	Paper Title
833	Fuzzy Logic Controlled 6-Phase PMSM Drive Under Various Operating Conditions
299	A Residual Dense Network Approach for False Data Injection Attack Localization in Power Grid
392	Smart Energy allocation for Electric Vehicles using Predictive Modelling
515	Machine Learning-Based Prediction of Distributed Solar Adoption
555	Cloud-Based Energy Management In Residential and Commercial V2G Networked Microgrid
278	Development of Agriculture Monitoring System for Eggplant Crop using Unmanned Aerial Vehicle
595	Operation Risk Based Optimal µPMU Placement In Distribution Network Considering Radial Buses
686	Automatic Control & Weight Monitoring of a Vacuum Based Grain Collecting Machine.
556	A Novel Sensor-less Model Predictive Direct Torque Control for PMSM Using Sliding Mode and Adaptive Disturbance Observers
795	A Comparative Study of Transformers based Machine Learning Models for Solar PV Power Forecasting

Oral Presentation-12 (Maths Seminar Hall)

Special Sessions: 1-7

Time: 04.30 PM – 6.00 PM

Session Chairs: Dr. Soumyabrata Barik, IIT ISM Dhanbad; Dr. Tushar Kanti, NIT Durgapur

Paper Ids	Paper Title
469	Battery Management System for Smart Wi-Fi Router Adapter for Rural Applications
575	PMU Placement to Estimate Power Mismatch for Frequency Stability Assessment
755	A Comparative Study of Battery State of Charge Estimation Techniques
428	Artificial Intelligence-Powered Real-Time Network Intrusion Detection System with Large-Scale Data Processing in Cloud Environments
480	Artificial Intelligence-Based Comparative Analysis of Wind Energy Forecasting Models
485	A Robust Machine Learning Approach for AC Microgrid Fault Diagnosis Using FFT and XGBoost
477	Improving Grid Stability and Balancing Renewable Power Intermittence with P2H2P Hybrid Power Systems Model: A Performance Study
487	A Universal Battery Charger with Wide Operating Voltage Range and Active Power Decoupling for Electric Transportation
669	Electricity Theft Detection using Ensemble-Based Machine Learning Classifier
481	Reliability Assessment of High Gain Coupled Inductor based Boost Converter for Fuel Cell Electric Vehicle using Markov Analysis

DAY 3 : 6th JULY 2025

Technical Session 3 (Oral Presentations: 13-18)

Oral Presentation- 13 (EED Seminar Hall)

Track 1: Power Conversion Technologies for Transportation Electrification and Sustainable Energy Integration

Time: 11.00 AM – 01.00 PM

Session Chairs: Prof. J. P. Mishra, NIT Silchar; Dr. Biswajit Sahoo, NIT Silchar

Paper Ids	Paper Title
483	Hybrid Ensemble Learning Technique for Efficient Fault Detection in AC Microgrid
712	Dual Duty Triple Mode Active Switched Inductors DC-DC Converter with Reduced Switch Voltage Stress
504	Design of a Bi-Directional Multi-Port Dc-Dc Converter for Hybrid Energy Storage in Electric Vehicles
533	Smart Energy Management in EV Charging Stations Using a PV-Based Boost Converter and Multilevel Inverter
601	Hybrid Adaptive Power Coordination based control and SODA MPPT for Fuel Cell-Battery EVs
608	An Integrated Converter for Electric Vehicle Charging using Grid and Solar Power with Minimal Components
338	Interior Permanent Magnet Synchronous Machine controlled through direct torque for Electric Vehicle
659	Design and analysis of high power bidirectional resonant converters for 800 -V battery charging applications

891	Four-plate capacitive wireless power transfer using LCL-LCL compensation for electric vehicle charging application
794	From Design to Road: Development and Performance Analysis of an Electric Jeep

Oral Presentation-14 (CIA Classroom)

Track 4: Energy Conversion and Management for Sustainable Smart Energy Systems and Rural Electrification

Time: 11.00 AM – 01.00 PM

Session Chairs: Prof. Senthil Kumar, NIT Trichy; Dr. Rangu Seshu Kumar, Vignan's Foundation for Science Technology and Research (VFSTR)

Paper Ids	Paper Title
618	Advanced Single-Stage on Grid Photovoltaic System for High-Efficiency DC Fast EV Charging Using SM-Sign NLMS Algorithm
325	Identify the Net-Zero Emission Pathways through Cross-Border Power Interconnection in the BIMP Region
379	Comparison of Optimization Techniques for Energy Conversion and Management in Sustainable Smart Energy Systems
474	Optimized Load Identification Using Total Harmonic Distortion and Artificial Bee Colony Algorithm
502	NILM Scheme Enabled Wide Range of Electrical Load Identification using SST and SVM Techniques
540	Adaptive Clustering for Distributed Load Management in Industrial Consumers: A Swarm-based Approach
770	WL-QHTGM-Based Adaptive Control of Grid- Connected PV System for Solar Water Pumping with PMSM Drive
832	Enhancement of Power Quality by Novel Control Method of Wind-AE-FC-BSS based Hybrid Microgrid under Faults on Distribution Lines
849	FOPID Controllers for Regulating Voltage of a Standalone SPV - Diesel Generator - Battery Bank based Power Supply System

Oral Presentation-15 (PESE Classroom)

Track 4: Energy Conversion and Management for Sustainable Smart Energy Systems and Rural Electrification

Time: 11.00 AM – 01.00 PM

Session Chairs: Prof. F. A. Talukdar, NIT Silchar; Dr. Tanmoy Malakar, NIT Silchar

Paper Ids	Paper Title
672	Advancing Industry 4.0 with Cloud-Integrated Cyber-Physical Systems for Optimizing Remote Additive Manufacturing Landscape

685	Smart Predictive Maintenance: AI-Driven Adaptation for Industrial Equipment
857	Design and Analysis of Novel Tristate Quasi-Z-Source Converter with Improved Dynamic Performance
316	Integrating PMU for fault analysis
470	Machine Learning Based Protection Strategy of Microgrid using Synchrophasor Measurement
486	Load Reduction of a Wind Turbine Using H- Infinity based Individual Pitch Control
708	Enhanced Pitch Angle and Battery Charging Control for Standalone Wind Power Systems Feeding DC Loads
332	Novel Advanced biocatalyst optimization algorithm for power loss diminution and voltage stability enhancement
476	Seamless Grid-Compliant EV Charging Using DAB with EPS Modulation for Adaptive Current Control and Power Factor Correction
370	Artificial Intelligence in Photovoltaics to Transform Solar Energy for Greater Efficiency and Scalability
632	Digital Twin Based on Neural Network for a Grid Connected Modular Multilevel Converters for HVDC Transmission

Oral Presentation-16 (CR-01)

Special Session 5: Artificial Intelligence and Machine Learning for Smart, Resilient, and Sustainable Energy Systems

Time: 11.00 AM – 01.00 PM

Session Chairs: Dr. Sreejith S., NIT Silchar; Dr. R. Dey, NIT Silchar

Paper Ids	Paper Title
324	Hybrid Metaheuristic Approach for Optimal LCL-Filter Design in Grid-Connected Inverters Using CSA-PSO with Adaptive Parameter Tuning
331	Optimizing Matrix Converter Performance Using Hybrid Particle Swarm Optimization and Gradient Descent Techniques
349	A Comprehensive Study of Ground Mount and Floating Solar PV System Performance in India for Electric Vehicle Green Charging
326	Hybrid Optimization Using Particle Swarm Optimization and Gradient Descent to Improve Phase Locked Loop Performance in Grid Connected Systems
496	Health Monitoring of Line Insulators Through Artificial Intelligence Based Surveillance System
746	Optimal Placement of Renewable Energy Sources and Fuel Cells in Power System Network
747	Maximum Power Point Tracking of Solar PV System using Novel Hybrid Algorithm
301	Detection and mitigation of cyber threat in deregulated multi -area LFC with renewable source.

Oral Presentation-17 (Project Lab)

Track 1: Power Conversion Technologies for Transportation Electrification and Sustainable Energy Integration

Time: 11.00 AM – 01.00 PM

Session Chairs: Prof. S. K. Biswas, Jadavpur University; Prof. B. K. Roy, NIT Silchar

Paper Ids	Paper Title
256	Enhanced Electric Vehicle Charging using a GaN-HEMT-based Buck Converter with a Resonant Gate Driver for Closed-Loop Operation
489	Dynamic Performance Analysis of PMSM Motors Using Fuzzy Logic PID Controller
445	Impact of Inner Radius Variation on Coil performance in WPT Systems
463	Adaptive Control-Based N-STATCOM for Harmonic Mitigation and Voltage Regulation in Grid-Connected Wind Energy Systems
571	Illustration of SOC controlled DC-DC Battery charger
769	Lyapunov based reference voltage tracking of a switched boost converter
806	High-Voltage Gain Bidirectional Z-Source DC-DC Converter for Efficient Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V) Applications

Oral Presentation-18 (Maths Seminar Hall)

Track 6: Automation, Control and Digitisation for Industry Applications

Time: 11.00 AM – 01.00 PM

Session Chairs: Dr. Ravita Lamba, IIT Roorkee; Dr. Tarkeshwar Mahto, SRM University AP

Paper Ids	Paper Title
906	Performance Assessment of Coil Structures for Wireless Charging in Underwater Vehicles
836	Acoustic Partial Discharge Signal Denoising using a Residual Convolutional Neural Network
462	Smart Urban Waste Management System Powered by AI and IoT for Efficient Collection, Segregation, and Disposal
611	An Efficient Two-Point DFT Interpolation Approach for M-Class Synchrophasor Measurement
626	Open-Circuit Fault Diagnosis in Multilevel Inverters Implementing PCA-WE-SVM Technique
637	MPC-Based Control of Dual Active Bridge Converter for DC-Link Voltage Stabilization in PV-Battery DC Microgrids
679	Real-Time Forest Fire Detection Using ESP32 Microcontroller with Cloud-Integrated Monitoring System
811	Experimental Comparative Analysis between IMC and Smith-Predictor on a Two-tank Level Control
897	Robust Virtual Inertia Control of a Microgrid Using Quantitative Feedback Theory
879	An Observer Based Phase-Locked Loop with DC-offset Rejection Capability for Single-Phase Grid-Tied Converter

IEEE IAS NE-IECCE Students Symposium (Poster Presentation Schedule)

DAY 1: 4th JULY 2025

IEEE IAS NE-IECCE Students Symposium

(Poster Presentation Session 1)

Venue: SAC Building (Near Central Library, NIT Silchar)

Time: 04.30 PM - 05.30 PM

Session Chairs: Dr. Hieu P. Nguyen, Texas Tech University; Prof. L. C. Saikia, NIT Silchar; Dr. Tarkeshwar Mahto, SRM University AP; Dr. M. Senthil Kumar, NIT Patna

Paper Ids	Paper Title
878	An eSO-CCF Based Fundamental Component Extraction for Three/Single-Phase System
663	Cost of Charging in a Solar Modules Integrated Electric Vehicles
460	State-of-Charge Estimation of Lithium-ion Capacitors Combining Impedance data and Deep Neural Network
396	A Modified Current Reference Generation Method for Minimizing Active Power Oscillations During Asymmetrical Low-Voltage Ride-Through (ALVRT) in Grid-Tied PV-Fuel Cell Systems
433	ANN Based Sampling Time Selection Criterion for Model Predictive Controlled Multilevel Converter
557	Design and Modeling of Inductorless Symmetric 9-Level Switched Capacitor Multilevel Inverter
853	A Method for Detecting and Mitigating Steady-State DC Bias Current in Dual Active Bridge Converter
888	Design and Analysis of Multi-Input SEPIC DC-DC Converter for UAVs Charging Applications
892	An Improved Methodology to Minimize Transient DC Bias Current in Dual Active Bridge Converter
893	Development and Simulation of a Dynamic Dual-Chamber Microbial Fuel Cell Model for Bioelectrochemical Energy Generation
894	Onboard EV Charger Using Totem-Pole PFC and Isolated DC/DC Converter for Enhanced Power Quality
688	Rotor Flux Model Reference Adaptive System based Speed Estimation for Field-Oriented Control of Induction Motor Drives
382	Peukert's Law Based Adaptive Control Strategy for EVs in VPP Based Energy Market
890	Dual-Polarised Broadband Antenna for RF Energy Harvesting in 5G Applications
513	Comparative Study of 6-sector and 9-sector DTC for Direct Drive-Wind Energy Conversion System
600	Comparative Performance of PI and ANN Controllers for DTC of a PMSG-based Direct-Drive Wind Energy Conversion System
742	Solar Array-Energized, Battery-Interfaced Sensored PMBLDC Motor-Propelled Water Pump Utilizing an Enhanced Landsman DC-DC Converter
887	Power Control of Offshore Grid by Frequency Matching for a DFIG Wind Power Farm Connected HVDC System under Voltage Fluctuatations
904	Strengthening GMPP in Off-Grid BIPV Systems with Array Interconnections Coupled DC-DC Boost Converters Under Partial Shading
631	Integration of Pico Hydro Power System with PV based DC Microgrid
365	Estimation of Oil- Paper Insulation of Transformer using Optical Coherence Tomography: An Image Texture Feature- Based Analysis
581	Generative pretraining transformer based false data injection attack detection framework for DC Microgrid under uncertain operating condition
750	A Cost-Effective Driver Drowsiness Detection Using Embedded Vision Systems using Raspberry Pi for Enhanced Road Safety
329	Decentralized Load Frequency Control of a Multi-Area Cyber-Physical Power System
570	Robust fault tolerant control based on adaptive backstepping terminal sliding mode
586	Advance Technology based Circuit Breaker acknowledge through PZEM-004T Module

619	Comparative Analysis of Control methods for Enhancing the Performance of the Bidirectional DC-DC Buck-Boost Converter
745	Fixed-Time Super Twisting Sliding Mode Average Consensus of Perturbed Multi-agent Systems
784	Development and Execution of a Model Predictive Control Technique for Hybrid Microgrid
453	Voltage Boosting Interleaved DC to DC Converter

DAY 2: 5th JULY 2025

IEEE IAS NE-IECCE Students Symposium

(Poster Presentation Session 2)

Venue: SAC Building (Near Central Library, NIT Silchar)

Time: 09.30 AM - 10.30 AM

Session Chairs: Dr. Krishanu Nath, NIT Jalandhar; Dr. Asadur Rahman, NIT Srinagar; Dr. Kumari Sarita, Government Engineering College Aurangabad, Bihar

Paper Ids	Paper Title
774	Artificial Neural Network Based Fault Detection and Classification in Power System
776	Assessment of optimum operating state of HVDC converters under uncertain operating condition of hybrid AC-DC power system through a stochastic optimization based approach
780	Techno Economic Assessment and Sizing Analysis of PV, Fuel cell and battery Microgrid using HOMER Pro
803	Hybrid Energy Management System Employing Hysteresis Control for DC Microgrid
808	A Novel Three Phase Seventeen Level Inverter for Grid Tied PV Applications
810	User Need Based Charging Strategies for Electric Vehicle
813	Resonance Stability Analysis of Hydropower Plant Using Modified RH Criteria in Consideration of Sub-Synchronous Oscillation
401	Reconfigurable Ultra-High Gain DC-DC Converter for Renewable Energy Sources
411	Equilibrium Analysis and Linearization of an Oscillating Water Column Energy System for Stability and Control
437	Multi-Input Single-Output Topology with BWO MPPT for Efficient Solar-Powered BLDC Motor Drives in SCVs
455	Analysis and Control of SIDO Boosting Gain Converter
494	Analysis and QFT based Controller for Buck and Boost Based Double Input DC-DC Converter
598	Comprehensive Analysis and Simulation of a Grid Integrated Bidirectional PV System with Battery
610	Simple and Unified Voltage Mode Control Strategy for DC-DC Boost Converters
612	Enhancing Nine-level Quadruple Boost Inverter Operation with Reduced Output Distortions
616	Slime Mould Optimization-Based Integral-LQR Control for Grid Following Inverters
620	Zero-voltage Transition of Dual-switch Based PWM Boost Converter
625	Possibility of Distributed Generation Integration Through Composite AC-DC scheme
781	DCM Analysis of a Two-Switch, Fifth-Order Buck-Boost Converter under Unequal Duty Ratios Scheme
821	SOGI based Three Phase G2V, V2G Technology
823	Enhancing Distribution System Performance with Concurrent Planning of DG and SOP
835	Optimal Allocation of DG to Enhance System Reliability, Resiliency and Power Quality using Optimization

839	Investigating the Potential of Lead-Free Perovskite/Kesterite Dual Absorber Architectures with Varied Transport Layer Materials for Optimizing Tandem Solar Cell performance
840	An Improved Switched Inductor Switched Capacitor based High Gain Converter for EV Application
877	Bidirectional Power Flow Control in Triple Active Bridge Converters with Sensitivity Analysis

DAY 2: 5th JULY 2025

IEEE IAS NE-IECCE Students Symposium

(Poster Presentation Session 3)

Venue: SAC Building (Near Central Library, NIT Silchar)

Time: 04.15 PM - 05.15 PM

Session Chairs: Dr. Rajen Pudur, NIT Arunachal Pradesh; Dr. Ujjal Chakraborty, NIT Silchar; Dr. Vipin Chandra Pal, NIT Silchar

Paper Ids	Paper Title
896	Recent Advances, Challenges and Future Prospects of Electric Vehicle (EV) Charging: A Technical Review
364	A High Gain Bidirectional Interlink DC-DC Converter to Integrate Unipolar and Bipolar DC Microgrids
366	Real-time Health Monitoring Framework for Rooftop Solar Panels: Efficient, Reliable, & Cost-effective Solution
431	Energy Management System for DC Microgrid: Balancing Sustainability and Economics
459	A Novel Passive Islanding Detection Method Using DFIG Stator Flux
461	Stability Analysis of a Solar PV Connected IEEE 33-Bus ON and OFF Grid Distribution Network
475	A Radial Basis Function Neural Network-Based Fault Detection Scheme for a Microgrid System
558	Ultra-High Voltage Gain Transformerless DC-DC Converter for Enhanced Renewable Energy Systems
567	Comparison in enhancement of GMPPs and LMPPs for new Hybrid cross-tie BIPV arrays under Non-uniform Shading Patterns
569	A Comprehensive Design and Analysis of Solar PV Emulator
584	Resilient Power Synchronization in Tactical Military Bases using CARO tuned enhanced TID Controller
593	Four port Bidirectional Converter with Sliding Mode Control for Hybrid Renewable Systems
617	A Coordinated Energy Management Control Scheme for a Grid-Integrated PV Hybrid Storage System
668	DC Bus Voltage Control in P&O MPPT based Wind-PMSG System using a DC-DC Bidirectional Converter with Storage System
673	Demand Response based optimally modified fractional cascade controller in hybrid AGC incorporating EV.
721	Optimized Frequency-Modulated MPPT Strategy for Enhanced Performance of CL3C Resonant Converter in PV Systems
723	Neural Network Based Wind Estimation and Predictive Control for Wind Energy Optimization
726	Efficient Solution of Multi-Period Three Phase OPF Problem Using Spatial Decomposition
741	A Design Oriented Dynamical Perspective on Proportional-Resonant Controller with 1-Φ Inverter
765	A Novel Resistance Switching Algorithm for Optimal Operation in Solar PV Systems
778	Robust Strategy for AGC and AVR in Isolated Hydropower Plants

783	Design and Implementation of Fuzzy Logic Control Strategy for PV-Battery Microgrid
786	Agro-Microgrid Frequency Stabilization Using Puma Optimizer Tuned Virtual Synchronous Systems
792	Design and Performance Comparison of Solar PV & PV/T Systems with Enhanced System Efficiency
605	Extended State Observer-based Controller for Cuk Converter

DAY 3: 6th JULY 2025

IEEE IAS NE-IECCE Students Symposium

(Poster Presentation Session 4)

Venue: SAC Building (Near Central Library, NIT Silchar)

Time: 11.00 AM - 12.00 PM

Session Chairs: Dr. Debayan Sarkar, NIT Silchar; Dr. Sudipta Chakraborty, NIT Silchar; Dr. Avadh Pati, NIT Silchar

Paper Ids	Paper Title
285	Load Frequency Control of Hydro Power Plant Microgrid Integrated with Solar Farms and BESS Using Genetic Algorithms for PID Controller
300	AI-Enhanced Framework for Predicting Shading and Soiling Impacts in Photovoltaic Systems
311	Novel Target Loop-Based IMC-PID Control Law for LF Regulation in Power Systems
335	Design & Development of StaLoi-Meter: IoT-based Standby Load monitoring & estimation system for household
350	Control Strategy for Grid Tied Hybrid System with Improved Power Quality, while Switching between GTM and IAM
858	Investigation on Different Magnet Geometries and Slot-Pole Combinations in Inner-Hollow Outer Rotor BLDC Motors for Yarn Feeding Textile Machinery
866	Performance Evaluation of Different Rotor Configurations in Brushless Permanent Magnet Motor for UAV Applications
328	Enhancing the frequency regulation in multi-area deregulated power system integrated with EV using modified LADRC controller
400	Target-loop based Cascaded Fractional-order Control for Non-integer Processes: Application on a PEM Fuel Cell
482	Enhancing the frequency regulation in hybrid deregulated AGC incorporating modified 2DOF cascaded controller.

TRACK 1:

Power Conversion Technologies for Transportation Electrification and Sustainable Energy Integration

A Quarter Wave Symmetry Based Modified Harmonic Minimization Scheme for 3-Phase 7-Level Cascaded H-Bridge Multilevel Inverter

Samudra Panda (National Institute of Technology Durgapur); Sourabh Kundu (Axiscades Technologies Limited); Subhendu Santra (Shiv Nadar Institution of Eminence DU); Subrata Banerjee (National Institute of Technology Durgapur)*

Abstract: In this study, a modified SHM PAM scheme is proposed for a 7-level cascaded H-bridge (CHB) multilevel inverter (MLI), which eliminates all the 5th harmonic components of the inverter line voltage while minimizing other lower-order harmonics. In this aspect, a new angular constraint is developed to satisfy four stringent grid code standards using a 7-level quarter wave symmetric voltage waveform. To determine the optimal switching angles and per-unit voltages of the proposed voltage pattern, the fitness function (FF), is formulated with comparatively minimal number of variables; thereby expediting and simplifying the overall computational process. The particle swarm optimization (PSO) algorithm is used to estimate the optimal solutions of the FF. Finally, the applicability of the proposed scheme is validated by MATLAB-simulation & experimentation to a CHB MLI setup. An FPGA based controller is used to generate the digital gate pulses of the hardware device.

Centrally Aligned Pulse Based One Cycle Control Technique for PWM Voltage Source Inverters

Debanjan Dhara (IIEST Shibpur); Ranajay Paul (IIEST Shibpur); Suvarun Dalapati (IIEST Shibpur)*

Abstract: One Cycle Control (OCC) is a non-linear control technique for switch-mode power electronic converters, which is capable of extracting fast response from the converter. Conventional OCC, when applied to inverters, usually generate edge-aligned pulses. This paper presents an improved version of OCC, capable of generating centrally aligned pulses for inverters, thereby pushing the higher order harmonics, as seen by the load, to nearly twice the switching-frequency. This technique, nominated as Centrally Aligned Pulse based OCC (CAPOCC) retains the 'fast-response' feature of conventional OCC, and requires only the pole-voltages of inverters to be sensed, for its implementation. This paper explains the principle of this CAPOCC technique for both single and three-phase inverters. It compares the same with conventional OCC and confirms its superior performance over conventional OCC based inverters through simulation and experimental results.

Interior Permanent Magnet Synchronous Machine controlled through direct torque for Electric Vehicle

*Anshu Choudhary Choudhary (NIT Durgapur); Partha Sarathee Bhowmik (NIT Durgapur)**

Abstract: In AC drives, independent variation of torque and flux is one of the renowned techniques due to its elementary control computation, easy numerical implementation, and robust operation attributes. This paper introduces the concept of independent torque regulation and its computational results. Various direct torque control (DTC) methodologies are available: DTC, model predictive DTC, duty ratio modulated DTC, and field-oriented control for permanent magnet synchronous machines (PMSMs). Among the above-mentioned control strategies, the DTC technique has been reviewed and analyzed, depending on the control performance of an IPMSM using a three-level voltage source converter.

Novel Single Switch Quadratic Boost Converter with Continuous Input and Common Ground

*Muzammil Ahmed (Tezpur University); Anish Ahmad (Tezpur University)**

Abstract: High-gain voltage converters are crucial for various applications, including renewable energy systems and electric vehicles. Non-isolated converters are often preferred for small and medium power ranges due to their simplicity, ease of design, and cost-effectiveness. Boost-derived converters are

particularly effective for such applications. While conventional quadratic converters provide high voltage gain, they are often limited by drawbacks such as a high component count, elevated stress levels, significant losses, and reduced efficiency. This paper introduces a novel quadratic boost-derived converter designed to address these issues. The proposed converter features a reduced component count, continuous input current, lower switching stress, common ground and reduced diode stress. Comprehensive operational details, steady-state analysis, and a comparative study with existing quadratic boost converters are presented. Experimental verification and validation confirm the superior performance and practicality of the proposed design.

A Non-Isolated Voltage Lift based Enhanced Quadratic Boost Converter

Bharath kumar Gulagattu (NIT Warangal); Pottabathula Raviteja (NIT Warangal); Varipalli Krupakar (NIT Warangal); M F Baba (Ecozen Solutions Pvt Ltd, Pune); K. Ashok Kumar (Vignan's Foundation for Science, Technology and Research); B L Narasimharaju (NIT Warangal); A V Giridhar (NIT Warangal)*

Abstract: This paper presents a novel Voltage Lift based Enhanced quadratic boost converter (VLEQB) topology that enhances the voltage gain by incorporating a voltage lift technique.The proposed configuration achieves higher output voltage by employing a parallel charging and series discharging for the inductor-capacitor cell. This approach offers several advantages, including input-to-output Common ground and the ability to maintain continuous input current (CIC), making it suitable for renewable energy applications.A detailed analysis is conducted on the VLEQB converter's steady-state operation in continuous conduction mode (CCM) . A comprehensive comparison with existing related topologies is carried out to highlight the unique features and potential benefits of the VLEQB converter. Furthermore, simulation results obtained using the PSIM platform for a 40/400 V,500W Converter validate the theoretical analysis, demonstrating strong agreement between simulated and theoretical findings.

A Novel Bridgeless Cuk-Cascaded Flyback PFC Converter for EV Charging

Varipalli Krupakar (NIT Warangal); Raghavendra Sunkesula (NIT Warangal); Bidyadhar Subudhi (NIT Warangal);B L Narasimharaju (NIT Warangal)*

Abstract: This paper presents a novel electric vehicle (EV) battery charger that combines a Bridgeless-Cuk converter with a flyback converter in series, providing an efficient power factor correction (PFC) solution with superior power density and fewer components. By eliminating the conventional diode bridge rectifier (DBR), the design enhances overall efficiency by reducing voltage stress on semiconductor devices and minimizing conduction losses. The flyback converter manages the battery charging process, while the Bridgeless-Cuk converter ensures a near-sinusoidal input current, achieving effective PFC.Operating in discontinuous conduction mode (DCM), the system minimizes the size of passive components and simplifies control, resulting in a more compact and cost-effective design. The proposed charger complies with IEC 61000-3-2 standards for total harmonic distortion (THD), ensuring high power quality across a broad range of input voltages and operating conditions. This advanced topology addresses key challenges in EV battery charging, offering a reliable, efficient, and power-quality-compliant solution with reduced component count, lower voltage stress, and enhanced power density, making it well-suited for modern electric vehicles.

Reconfigurable Ultra-High Gain DC-DC Converter For Renewable Energy Sources

Raghavendran S (SASTRA University); Susthir Gourishetti (SASTRA University); Lenin Prakash (SASTRA University)*

Abstract: A Reconfigurable Ultra-High Gain (RUHG) DC-DC boost converter capable of operating with cubic or quadratic voltage gain is presented. Low-voltage DC sources like Fuel cells, Photovoltaic,

etc., can be interfaced with DC microgrids through the proposed RUHG converter. A low-voltage and an ultra-low voltage source can be connected with the proposed RUHG converter and the converter will be reconfigured depending on the connected source and the required gain. The detailed operational analysis of the proposed converter is presented, and the performance of the converter is validated through MATLAB simulation by interfacing two Photovoltaic (PV) sources with different voltage ranges.

Equilibrium Analysis and Linearization of an Oscillating Water Column Energy System for Stability and Control

Sunil Kumar Mishra (Kalinga Institute of Industrial Technology); Akshaya Kumar Pati (Kalinga Institute of Industrial Technology); Amitkumar Vidyakant Jha (Kalinga Institute of Industrial Technology); Bhargav Appasani (Kalinga Institute of Industrial Technology); Vijay Kumar Verma (Indian Space Research Organisation (ISRO)); Avadh Pati (National Institute of Technology Silchar); Amritesh Kumar (National Institute of Technology Silchar)*

Abstract: Oscillating Water Column (OWC) systems offer an effective approach for wave energy conversion, but their nonlinear dynamics create challenges for stability and control. This study conducts a systematic equilibrium analysis, addressing steady-state rotor speed and flux linkages to further study system stability assessment and control tuning. Solving nonlinear equilibrium equations provides insights into the system's steady-state behavior. The OWC state-space linearization framework employs Jacobian matrices and then, the nonlinear and linearized OWC models are compared. The results confirm the necessity of equilibrium-based modeling and error estimation to refine control strategies. A detailed assessment of linearization errors establishes the extent to which the linearized OWC model represents the nonlinear system, ensuring the applicability of classical control techniques. The proposed framework enhances the understanding of OWC stability, establishes a foundation for control design, and improves energy extraction efficiency.

Multi-Input Single-Output Topology with BWO MPPT for Efficient Solar-Powered BLDC Motor Drives in SCVs

Alok Ranjan (IIT Dhanbad); Aashish Acharya (Institute of Engineering Pulchowk Campus, Nepal); Snehil Verma (IIT Dhanbad)*

Abstract: This paper presents a multiple inputs single output (MISO) DC-DC converter-based model of an energy efficient solar-powered brushless DC motor drive for small commercial vehicles. Energy efficiency of the system is ensured by extracting maximum power available from the solar photo-voltaic (SPV) arrays at different working conditions using a novel Black Widow Optimization (BWO) based Maximum Power Point Tracking (MPPT) algorithm. For smooth and reliable operation of the drive a battery bank is integrated to the system that operates in parallel with the SPV arrays to establish a constant dc bus using a bidirectional converter as an interface to the bus. The effectiveness of the system under varying scenarios of temperature and irradiance is validated through simulation results.

Impact of Inner Radius Variation on Coil performance in WPT Systems

Tushar Debnath (National Institute of Technology Mizoram); Suman Majumder (National Institute of Technology Mizoram); Krishnarti De (National Institute of Technology Mizoram)*

Abstract: The rise of greener automobiles, made possible by wireless power transmission, has changed and boosted the transportation industry. Wireless transmission has gained popularity because of its many benefits, although misalignment is problematic. These days, one of the most frequent causes of misalignment in the vertical parallel position is due to variations in the inner radius for both static and dynamic charging. The impact of coil radius in vertical misalignment during charging is the main focus

of this work's analysis. 3D FEM simulation is used to build and analyze a very simple, low-cost, square-type transmitter-receiver coil with asymmetric properties. According to the analysis, the mutual inductance, coupling coefficient, and transmission efficiency all rise with values of 5.1501 µH, 0.1866, and 96.65% at 9.855 cm when the receiver coil's varying radius causes misalignment. At 189.071, the Q-factor is also rather high. The effect of flux density and magnetic field strength is calculated with the best value at a 6.46 cm radius and a maximum value of 48A/m and 56µTesla.

Voltage Boosting Interleaved DC to DC Converter

Ankit Dhiman (NIT Hamirpur); Jiwanjot Singh (NIT Hamirpur)*

Abstract: In this paper, a new architecture of high-gain interleaved DC to DC converter has been presented. An interleaved structure consists of three stages which includes active clamp circuit with built in transformer, passive lossless clamp circuit and an asymmetrical voltage multiplier cell. In comparison to exiting configurations of high-gain converters, suggested converter has achieved a noticeably larger voltage gain. A simulation study has been carried out of a 2.3-kilowatt converter. The enhanced high gain performance is confirmed by MATLAB Simulation.

Analysis and Control of SIDO Boosting Gain Converter

Dr. M. Veerachary (IIT Delhi); Shreyansh Upadhyaya (IIT Delhi)*

Abstract: This paper presents analysis and control of boosting gain single-input double output converter (BG-SIDO). It is a two-switch based fifth-order converter and is having common ground among the outputs. It is capable of ensuring different boosting gains for its double outputs. Switch gate pulse-width modulation signals controlling allows to realize desired boosting voltages at the outputs. For controlling purpose, the two outputs should be monitored separately and corrective action (different duty ratios) should be given to the two-switches. Since the two switches are inter-connected in between the source and loads through L-C elements. Any change in one switch duty ratio reflects other output voltage and vice-versa. To understand this phenomenon, detailed mathematical analysis is established here and then suitable controllers are designed. For controllers' design, multi-input multi-output systems control theory is adopted. BG-SIDO converter performance predetermination is carried out using PSIM simulations. For demonstration, scale-down prototype BG-SIDO converter is fabricated and validating experimental results are given which are close agreement with the analysis.

Adaptive Control-Based N-STATCOM for Harmonic Mitigation and Voltage Regulation in Grid-Connected Wind Energy Systems

Ramesh Kumar (National Institute of Technology Mizoram); Tammi Chakma (National Institute of Technology Mizoram); Chandan Kumar (National Institute of Technology Mizoram)*

Abstract: Integrating wind energy systems into gridconnected networks poses power quality (PQ) challenges, such as voltage fluctuations, harmonic distortions, and reactive power issues, affecting system stability and efficiency. This paper proposes a Novel Static Synchronous Compensator (N-STATCOM) to enhance PQ through dynamic reactive power compensation, mitigating voltage sags, swells, flickers, and harmonics while optimizing the power factor. Using MATLAB/Simulink, the system's performance is evaluated under varying wind speeds and load conditions. Results show that N-STATCOM improves voltage stability, reduces total harmonic distortion (THD), and enhances reactive power compensation compared to traditional STATCOMs. Its control strategy ensures rapid response to grid disturbances, maintaining consistent PQ. This study demonstrates N-STATCOM's effectiveness in addressing PQ issues, offering insights for integrating renewable energy while ensuring grid reliability and efficiency.

Hybrid Ensemble Learning Technique for Efficient Fault Detection in AC Microgrid

Dr.Rudranarayan Pradhan (Odisha University of Technology and Research, Bhubaneswar, Odisha); Sushant Kumar Meher (Odisha University of Technology and Research, Bhubaneswar,Odisha); Jeeban Jyoti Mohanty (Odisha University of Technology and Research, Bhubaneswar,Odisha); Omkar Mohanty (Odisha University of Technology and Research, Bhubaneswar,Odisha); Tapan Kumar Sahoo (National Institute of Technology, Warangal)*

Abstract: Microgrids are localized energy systems integrating distributed energy resources (DERs) such as solar, wind, and conventional generators to enhance grid reliability and sustainability. However, their decentralized nature and bidirectional power flow introduce significant fault detection challenges. Traditional protection schemes struggle with dynamic fault conditions, necessitating advanced machine learning (ML) techniques for improved accuracy. This paper presents an ensemble learning approach incorporating a Random Forest Classifier, XGBoost, and Support Vector Classifier (SVC) to detect faults in a microgrid environment. The proposed model leverages historical voltage and current data to classify different fault types, achieving a high detection accuracy of 99.2%. Simulation results demonstrate the model's effectiveness, outperforming conventional methods and individual classifiers in fault identification.

Analysis and QFT based Controller for Buck and Boost Based Double Input DC-DC Converter

Dr. M. Veerachary (IIT Delhi); Varun Mishra (IIT Delhi)*

Abstract: The paper examines the application of the Quantitative Feedback Theory (QFT) robust control strategy to the Buck and Boost Based Double Input Converter (BBBDIC). This approach is used for controllers in MIMO (Multi input-Multi output) systems with model uncertainty. The proposed controller is developed to achieve robust performance while addressing plant uncertainties and external disturbances. The controllers are validated through performance specifications. The model of a MIMO plant consists of multiple internal paths that create interconnections between the plant's inputs and outputs. To analyze the QFT methodology, two independent diagonal controllers are employed. Simulations are performed using MATLAB and PSIM tools to evaluate the performance of the BBBDIC converter and the robust controller. A 60/12 V to 42 V, 100 W, 50 kHz ratings are taken into account to validate the controller within the simulation environment. Designed controller set is also tested experimentally and thus validating the QFT design.

Design of A Bi-Directional Multi-Port DC-DC Converter For Hybrid Energy Storage In Electric Vehicles

Bharadwaj S (Sri venkateswara college of engineering); Mohanty NK (Sri Venkateswara College Of Engineering)*

Abstract: Usage of Electric Vehicles (EVs) in wide scale reduces the increasing consumption of fossil fuels in the transportation system. EVs consists of three major units namely, battery pack, power electronic converter (PEC) and electric motor. The PEC incorporates two or more DC-DC converters, each with a specific purpose like charging the battery, powering the motor and supplying ancillary loads. EVs utilize battery as its major source of energy along with other sources like PV or fuel cell. In order to effectively utilize the EVs, the conventional PECs can be replaced with a central power converter which reduces the cost and improves the functionality. This work introduces a multi-port Bi-directional DC-DC converter with a charge controller to automate battery charging and discharging processes allowing hybridization of available energy sources for effective power management. The proposed converter can be operated in regenerative braking mode improving efficiency. Based on the variations in load demand and availability of energy sources, the proposed converter setup was tested in battery charging, discharging and regeneration modes using MATLAB/Simulink and an efficiency of 90% was achieved.

Smart Energy Management in EV Charging Stations Using a PV-Based Boost Converter and Multilevel Inverter

Busireddy Hemanth Kumar (Mohan Babu University, Tirupathi); Vyanktesh Panchkumar Dhote (Government College of Engineering, Jalgaon); E Parimalasundar (Mohan Babu University, Tirupathi); Rangu Seshu Kumar (Vignan's Foundation for science technology and research)*

Abstract: This paper presents a high-efficiency grid-integrated electric vehicle (EV) charging system powered by a photovoltaic (PV) source. The system consists of a PV panel, a boost converter, and a seven-level multilevel inverter (MLI) to ensure stable and high-quality power delivery to the grid and EV charging station. The proposed system operates at grid operating conditions. The boost converter maximizes power extraction from the PV panel, while the MLI improves output waveform quality, reducing total harmonic distortion (THD). A SPWM technique is employed for optimal switching, minimizing power losses, and ensuring high efficiency. The system's performance is evaluated through MATLAB simulations, analyzing the system parameters. The results confirm that the system achieves low THD, high efficiency, and stable grid operation viable for sustainable EV charging infrastructure. A comparative analysis of the proposed system over a conventional 2L inverter has been presented.

Design and Modeling of Inductorless Symmetric 9-Level Switched Capacitor Multilevel Inverter

*Kakula Khumukchamba (NIT Silchar)**

Abstract: This work presents a new topology for a symmetric 9-level switched capacitor-based multilevel inverter that operates with a single voltage source. The term "symmetric" refers to the uniform voltage difference between any two consecutive output voltage levels. The proposed model features a voltage source connected in parallel with three capacitors. The circuit incorporates fourteen IGBT switches without antiparallel diodes, three capacitors, and one DC voltage source. This configuration allows for the generation of an output voltage that is twice the value of the input voltage. The topology introduces an innovative method for obtaining the output voltage across the load by utilizing the voltage drop across the on-state resistances of the switches. As a result, it is possible to produce more output voltage levels with minimal voltage boosting. The paper discusses the working principle, the selection of capacitor sizes, voltage stress analysis, a comparative analysis, and simulation results of the proposed inverter.

Illustration of SOC controlled DC-DC Battery charger

Nirjhar Barman (Tezpur University); Shyamantak Raj Barman (Tezpur University); Anurodh Yadav (Tezpur University); Asim Datta (Tezpur University)*

Abstract: Battery for EVs typically require lower voltage levels for charging than the voltage supplied from a power source. A cascaded boost-buck conveniently fulfills our need of High and low voltage at the same time. DC-DC Buck converter efficiently steps down the voltage to the optimal level required by the EV battery, ensuring a stable and regulated output voltage and current, which is crucial for safely charging EV batteries. This paper aims for design and analysis of DC-DC Battery charger that can be used for EV Battery charging applications. The system employs has an input voltage of 380 V and is integrated to a 48 V, 100 Ah Lead-Acid battery. The simulation results demonstrate the system's effectiveness in minimizing energy loss during conversion, thereby enhancing overall efficiency. The experimental result of the modified cascaded DC-DC converter is presented in this work.

Comprehensive Analysis and Simulation of a Grid Integrated Bidirectional PV System with Battery

Nikesh Nongthombam (NIT, Manipur); Shuma Adhikari (NIT, Manipur); Laishram Khumanleima Chanu (NIT, Manipur)*

Abstract: This paper offers detailed simulation and complete analysis of a bidirectional photovoltaic (PV) system that features grid connection along with battery storage. The system consists of PV array, a DC/DC converter, and a bidirectional inverter. It also has an advanced control system technique that includes Maximum Power Point Tracking (MPPT), battery management, and grid interaction. Every simulation result verifies the system's capability to manage each aspect of power distribution effectively, as well as to respond to every load variation, in addition to maintaining complete overall stability. Key parameters, which include PV voltage and current, battery power, and grid interaction, are thoroughly addressed for system performance analysis and evaluation. The results indicate that the control strategies optimize energy utilization and guarantee stable operation.

Hybrid Adaptive Power Coordination based control and SODA MPPT for Fuel Cell-Battery EVs

Swapnil Singh (IIT Jodhpur); Nishant Kumar (IIT Jodhpur)*

Abstract: This paper presents an energy management framework for Fuel Cell-Battery Electric Vehicles (FCEVs) using a Hybrid Adaptive Power Coordination (HAPC) strategy and a Second Order Derivative-based Adaptive (SODA) MPPT technique. The system integrates a fuel cell as the primary power source, supported by a battery for auxiliary energy needs. The key components include a boost converter for voltage regulation, a bidirectional DC-DC converter for battery energy management, and an inverter for motor control. The proposed SODA MPPT enhances power tracking accuracy, reduces oscillations, and ensures optimal fuel cell utilization. The overall hybrid approach improves efficiency and system stability under varying power demands, making it suitable for real-world EV applications.

An Integrated Converter for Electric Vehicle Charging using Grid and Solar Power with Minimal Components

Manish Kumar (IIT Roorkee); Bhabani Choudhury (IIT Roorkee); Mukesh Kumar Pathak (IIT Roorkee)*

Abstract: This work proposes a novel integrated converter for Electric Vehicles (EVs) chargers. The proposed converter system allows a solar photovoltaic (PV) system and utility grid to be deployed in tandem for battery-charging operations. The devised charging system has fewer components because both sources use the same converter (working independently). A modified bridgeless (BL) single-ended primary-inductor converter (SEPIC) is used for grid power. It offers an EV charging option that is both inexpensive and has a high-power density. The charger’s efficiency is increased since it uses fewer devices to operate during a switching cycle. This lowers the additional conduction loss that a typical charger's diode bridge rectifier would otherwise experience. A flyback converter synchronizes the commands for charging batteries during periods of constant voltage and constant current for solar power and grid power. Utilizing solar power and AC mains, the proposed charger is built in discontinuous conduction mode (DCM) and has low reverse recovery losses in circuit diodes, as well as the ideal inherent zero current switching operation. The MATLAB/Simulation platform is used here to assess the enhanced performance of the modified BL SEPIC EV charger with grid and solar power.

Simple and Unified Voltage Mode Control Strategy for DC-DC Boost Converters

Roushan Kumar (National Institute of Technology Patna); G Lloyds Raja (NIT Patna); Md Nishat Anwar (National Institute of Technology Patna)*

Abstract: Boost converters (BCs) are of various types that differ in dynamics and order. However, existing control strategies are often limited to a particular type of BC and majority of them are complex thereby limiting its usage in practical applications. To address this gap, a proportional-integral (PI) controller design method based on a moments-matching approach is suggested. The adjustable

parameter of the PI controller is selected for required maximum sensitivity The efficacy of this unified approach in maintaining the output voltage of converters as per user-defined reference is demonstrated on benchmark models of BC and High Gain Boost Converter (HGBC). Results show faster dynamic performance and settling time compared to some contemporary PI designs (H_∞ and internal model control-based) while tracking reference voltage. Performance enhancement achieved by the suggested design is quantified in terms of time-domain performance measures.

Enhancing Nine-level Quadruple Boost Inverter Operation with Reduced Output Distortions

*Roshan Kumar (National Institute of Technology Patna); Sweta Prasad (National Institute of Technology Patna); M Senthil Kumar (National Institute of Technology Patna); G Lloyds Raja (NIT Patna)**

Abstract: The distortion produced in the voltage waveform of the inverter hinders its operation at high power. To overcome this issue, this paper presents the modeling of the nine-level quadruple boost (NLQB) inverter and closed-loop control of the same using a proportional-integral (PI) controller. The single DC-sourced NLQB inverter uses 10 insulated gate bipolar transistor switches and two switched capacitors. A cascaded PI controller is designed (for voltage and current control) in the aforementioned NLQB inverter to maintain its output voltage at a desirable level. Further, the performance of this inverter after employing a PI controller is studied with harmonic analysis using a fast Fourier transform. Compared with the open-loop operation of this NLQB inverter, the suggested cascaded PI-based closed-loop system produces fewer harmonics and total harmonic distortion.

Slime Mould Optimization-Based Integral-LQR Control for Grid Following Inverters

Souvik Roy (University of Calcutta); Arijit Basak (University of Calcutta); Abhishek Majumder (Future Institute of Technology); Sumana Chowdhuri (University of Calcutta)*

Abstract: Efficient control of three-phase voltage source inverters (VSIs), commonly referred to as grid following inverters (GFIs), is crucial for seamless integration of distributed energy resources (DERs) with the existing grid infrastructure. Traditional proportional-integral (PI) controllers for GFIs struggle with dynamic performance and parameter variations. This paper proposes an Integral-Linear Quadratic Regulator (LQR) control optimized using the Slime Mould Optimization (SMO) algorithm for grid following inverter control. LQR enhances transient response and disturbance rejection, while integral control ensures steady-state accuracy. SMO efficiently tunes LQR weight matrices, improving system robustness and reducing steady-state error. Simulation results validate the proposed approach, demonstrating superior dynamic performance and enhanced robustness compared to conventional methods. This study lays the foundation for advanced and optimal control of inverters, enabling seamless integration of DERs with existing utility grid thereby paving the way for sustainable energy integration.

Zero-voltage Transition of Dual-switch Based PWM Boost Converter

Dr. M. Veerachary (IIT Delhi); Venugopal Bathala (IIT)*

Abstract: Use of conventional boost converter cell as zero-voltage transition (ZVT) cell for dual-switch based boost converter gives soft-switching operation for switches but at the expense of increased current stress. In this paper, an attempt is made to reduce the current stress by using modified ZVT-cell. This cell uses all the elements used in conventional boost cell but they all are connected in series across the switched-capacitor cell. The switched-capacitor cell based dual-switch converter along with the modified ZVT cell attains better voltage gain at moderate duty ratio values together with soft-switching

of the devices. Also, the diodes turn-OFF when their voltage becomes close to zero leading to zero current switching operation. Principle of operation is explained through key waveforms and theoretical analysis is formulated by examining various zones that the converter exhibits in one switching cycle. For concept demonstration, simulation results are given first and finally experimental observations of prototype are included for comparison purpose.

Possibility of Distributed Generation Integration Through Composite AC-DC scheme

*Shaista Parveen (Aligarh Muslim university)**

Abstract: In the past, electricity was generated solely at large centralized generating stations and transmitted through transmission and distribution networks in order to reach customers. However, emerging trend is towards distributed generation where local energy sources play a vital role in electricity supply. Since this transition required bidirectional converters to interconnect AC and DC grids which results in lower efficiencies, increased harmonics, and multiple cconversion issues. To address these challenges, this paper provides the concept of composite AC-DC transmission, where ac and dc power flows are integrated within the same line to establish a composite AC-DC distribution grid. The composite AC–DC grid provides a grid-connected interface for a large number of distributed generations, making it possible for local consumption of distributed generation. The composite AC-DC grid serves as an interface for distributed generation sources, facilitating local energy consumption and seamless integration into the larger utility grid. In this paper, the Composite AC-DC Grid is simulated in a PSCAD/EMTDC environment incorporating solar PV plants, mini Hydro plant, wind turbine generations with synchronous generator and diesel generator. Simulation results demonstrate the feasibility and effectiveness of implementing the composite AC-DC distributed grid.

Design and analysis of high power bidirectional resonant converters for 800 -V battery charging applications

Padmavathi L, CSIR Ceeri Pilani

Abstract: This paper presents the design and analysis of a high power bidirectional resonant converter suitable for 800-V battery charging applications. The topology used is a bidirectional CLLC resonant converter which is an isolated DC-DC converter topology typically preferred in high voltage battery charging applications. A 22- kW bidirectional CLLC resonant converter and its resonant tank parameters are designed with the identification of switching frequency range to regulate the battery voltage in the range of 550 – 850 V from a nominal DC bus voltage of 800 V. The analysis of bidirectional operation with switching waveforms and efficiency evaluation are carried out in forward and backward modes of power transfer and simulation results are presented.

Dual Duty Triple Mode Active Switched Inductors DC-DC Converter with Reduced Switch Voltage Stress

Motiur Mohammed (khalifa university); Vinod Khadkikar (Khalifa University); Bashar Zahawi (Khalifa University); Omar Al Zaabi (Khalifa University)*

Abstract: This paper presents a new dual-duty triple switch (DDTM) high-voltage gain DC-DC converter topology for DC microgrids. The proposed DC-DC converter integrates a modified active switched inductor (mASL) cell with a symmetrical switched capacitors (SSC) cell to achieve very high voltage gain and very low voltage stress. The mASL cell incorporates a unidirectional switch across the inductors of the conventional ASL cell, enabling dual-duty triple-mode operation. This feature adds

flexibility in achieving the desired output voltage using different combinations of duty cycles. The SSC cell of the proposed converter not only enhances the voltage gain but also suppresses voltage oscillations in the ASL cell, resulting in reduced voltage stress across the switches. The operating principles, steady-state analysis, and comparative evaluation are provided. Finally, the performance of the proposed converter is validated using a laboratory prototype (24V/318V).

Stability Assessment of an IBR-based LFC System using Grid-Forming (GFM) Inverter Control

Mansha Ali (National Institute of Technology Srinagar, J&K); Asadur Rahman (National Institute of Technology Srinagar); Suriya Sharif (National Institute of Technology Srinagar, J&K)*

Abstract: The shift in electrical power generation is inevitable as inverter-based resources (IBRs) are increasingly integrated into the utility grid. However, the integration of these lowinertial IBRs presents challenges in maintaining the frequency stability of the grid. The grid-connected inverters operating in grid-following (GFL) mode control their output through a phase-locked loop (PLL). Since GFL inverters do not actively regulate voltage and frequency, their ability to provide ancillary support to the grid is limited. These limitations have led to the development of grid-forming (GFM) control techniques, which allow inverters to function similarly to synchronous generators. Unlike GFL inverters, GFM inverters actively regulate their frequency output, enabling them to support system frequency while accommodating changes in load demand. The present study explores implementing GFM inverter control in a single-area load frequency control (LFC) system comprising thermal, solar, and electric vehicle (EV) sources. The required model is developed and analyzed using MATLAB Simulink®. The magnetotactic bacteria optimization (MBO) technique is employed to optimize the controller gains for the LFC and GFM control loops of the proposed power system model. The simulation results indicate that the integration of GFM inverters enhances the frequency and overall stability of the power system.

Lyapunov based reference voltage tracking of a switched boost converter

Chandan Kumar (NIT Sikkim); Anjan Kumar Ray (NIT Sikkim)*

Abstract: This article presents output voltage tracking for a DC-DC boost converter. The main objective is to find the voltage across load which facilitates the tracking of an output reference voltage. For this, the state space averaging model is employed to design the final state space equation for boost converter. The formula for the continuous controller is then generated using the backstepping control technique. The Lyapunov control theory is used to assess the stability of the boost converter, resulting in a minimum tracking error that approaches to zero. Finally, the applicability of the proposed controller is assessed using a simulation platform. Further, a comparative study ensures the efficacy of the proposed work.

DCM Analysis of a Two-Switch, Fifth-Order Buck-Boost Converter under Unequal Duty Ratios Scheme

Utkarsha Dey (IIT Delhi); Mummadi Veerachary (IIT Delhi)*

Abstract: This paper explores the operation of a fifth- order Switched-Capacitor Bridge DC-DC Converter (SCBDDC) in Discontinuous Conduction Mode (DCM), building on prior work that assumes ontinuous Conduction Mode (CCM). The SCBDDC, which integrates a switched-capacitor bridge to achieve a non-linear buck-boost voltage gain, is analyzed under synchronous unequal duty ratios (DS1 < DS2). The operation of the converter in both CCM and DCM are discussed, with emphasis on deriving

the boundary conditions for the CCM-to-DCM transition and the voltage gain under DCM operation. Simulation results to validate the theoretical analysis are also included.

From Design to Road: Development and Performance Analysis of an Electric Jeep

Dileep G (Jigme Namgyel Engineering College, Bhutan); Norden Wangchuk (JNEC); Amritesh Kumar (NIT Silchar); Sreekanth Nethagani (Jigme Namgyel Engineering College); Arunkumar C R (Visteon Corporation); Phurba Wangchen (Jigme Namgyel Engineering College); Sonam Dremey (Jigme Namgyel Engineering College); Suk Moti Subba (Jigme Namgyel Engineering College)*

Abstract: This study presents the design and fabrication of an electric jeep (E-Jeep) tailored for deployment at Jigme Namgyel Engineering College, with a primary objective of enhancing campus security through sustainable transportation. The E-Jeep is designed to resemble a conventional four-wheeled vehicle, a widely used mode of transport in various Asian cities. The conceptualization and structural design were carried out using SolidWorks software, facilitating a comprehensive 3D model for precise fabrication. Locally sourced materials were utilized to ensure cost-effectiveness and ease of manufacturing. A key component of the E-Jeep is its propulsion system, which employs a 5 kW, 72V six-phase permanent magnet brushless direct current (PMBLDC) motor, selected based on calculated power requirements to optimize efficiency and reliability. The motor is powered by a battery pack, providing the necessary energy for sustained operation. The vehicle has a total mass of approximately 1000 kg, contributing to a robust and durable structure. Additionally, the E-Jeep is designed to achieve a maximum speed range of 30–40 km/h, ensuring safe and efficient mobility within the campus. This project demonstrates a practical approach to electric vehicle implementation in academic institutions, promoting sustainability and energy-efficient transportation solutions.

High-Voltage Gain Bidirectional Z-Source DC-DC Converter for Efficient Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V) Applications

*Deepsikha Saikia (Tezpur University); Anish Ahmad (Tezpur University)**

Abstract: This paper presents an analysis and working of a high-voltage gain switched Z-source bidirectional DC-DC converter for single-phase vehicle-to-grid (V2G) and grid-to-vehicle (G2V) operations. The focus is on power conversion technologies and control methods for facilitating two-way charging between electric vehicles (EVs) and the power grid. The converter enables efficient energy transfer, helping to manage peak load demands, stabilize the grid, optimize energy use, and integrate renewable energy sources, ultimately providing economic benefits. The paper explores the development of efficient bidirectional Z-source converters and their integration into EVs, supporting both V2G and G2V functionalities. The primary goal is to examine the working of this converter, which contributes to the advancement of smart grid technologies, ensuring the seamless integration of EVs into the power grid and vice versa, promoting a sustainable transportation future. By combining advanced bidirectional switched converter designs with control algorithms, this study achieves fast operation switching, different mode operations and reducing system complexity. Simulation results validate the proposed converter's effectiveness for V2G and G2V operations.

SOGI based Three Phase G2V, V2G Technology

*Pranay Sahay (IIT(ISM) Dhanbad); Sagar Babu Mitikiri (IIT(ISM) Dhanbad); Preet Samanta (IIT(ISM) Dhanbad); Tushita Das (IIT(ISM) Dhanbad); Vedantham Lakshmi Srinivas (IIT(ISM) Dhanbad)**

Abstract: The increase in electric vehicle mobility has facilitated the development of grid-to-vehicle (G2V) and vehicle-to-grid (V2G) technologies. Electricity can flow both ways between the grid and the batteries of electric vehicles. This paper presents a second-order generalized integrator (SOGI) filter based bi-directional voltage source converter (VSC) in conjugation with a PI-based bi-directional DC-

DC converter. The proposed system ensures smooth power flow during both vehicle-to-grid (V2G) and grid-to-vehicle (G2V) operations while maintaining power quality indices. The total harmonic distortion (THD) remains within the limits specified by IEEE standards, such as IEEE 519. A sample-and-hold circuit is employed to estimate the fundamental component of the grid current, contributing to grid synchronization across all operating modes. Additionally, the transition between V2G and G2V modes is seamlessly achieved.

Enhancing Distribution System Performance with Concurrent Planning of DG and SOP

Hemant Patel (NIT Durgapur); Aashish Kumar Bohre (National Institute of Technology Durgapur); Omkar Yadav (National Institute of Technology Durgapur)*

Abstract: The increasing demand for reliable and efficient power distribution necessitates advanced optimization techniques to minimize losses. This study presents an Adaptive Particle Swarm Optimization (APSO)-based concurrent planning approach for the optimal placement of Soft Open Points (SOP) and Distributed Generation (DG) in a distribution network. By strategically integrating DG and SOP, the system experiences significant improvements in power loss reduction, voltage stability, and reliability. The multi-objective function is considered based on various technical performance parameters for the 33-bus RDS to identify the most suitable locations and sizes for multiple DGs and SOPs. The effects of voltage profile, reactive power, and active power losses are also examined. These outcomes confirm that the concurrent planning of DG and SOP using APSO is an effective strategy for improving distribution system performance, ensuring a more resilient, cost-effective, and sustainable power network.

Optimal Allocation of DG to Enhance System Reliability, Resiliency and Power Quality using Optimization

Hemant Patel (NIT Durgapur); Aashish Kumar Bohre (National Institute of Technology Durgapur); Raja kumar Das (National Institute of Technology Durgapur)*

Abstract: The resiliency in electrical distribution systems (DG) is critical for ensuring a continuous and reliable power supply, particularly in the face of disruptions such as natural disasters, equipment failures, or sudden demand spikes. This paper presents a comprehensive analysis of the impact of DG on power system reliability, resiliency, and efficiency. The study evaluates key reliability indices, voltage stability, and power loss reduction under two scenarios: without DG (Base Case) and with DG. The African Vultures Optimization Algorithm (AVOA) algorithm integrated with DIgSILENT Power Factory is employed to determine the optimal DG placement and sizing. The results indicate that DG integration significantly improves system reliability by reducing SAIFI, SAIDI, and ENS indices, enhancing voltage profiles, and minimizing active and reactive power losses. Furthermore, resiliency analysis is conducted under uncertain conditions, where a 25% load reduction is considered due to a catastrophic event such as a tsunami. The findings reveal that the system remains stable despite the reduced load, as DG enhances adaptability and ensures faster recovery from disturbances. In addition to reliability and resiliency improvements, the impact of Total Harmonic Distortion (THD) is also analysed. The integration of DG introduces harmonic distortions due to inverter-based power generation, which affects power quality. The study examines THD levels before and after DG implementation, ensuring that the harmonic distortion remains. The results demonstrate that proper DG sizing and placement mitigate excessive harmonics, maintaining a stable and high-quality power supply.

Investigating the Potential of Lead-Free Perovskite/Kesterite Dual Absorber Architectures with Varied Transport Layer Materials for Optimizing Tandem Solar Cell performance

Raja Agarwala (Hajee Mohammad Danesh Science and Technology University); Prince Kumar (National Institute of Technology Silchar); Safra Binte Sabbir (Hajee Mohammad Danesh Science and Technology University); Mehedi Hasan Tanim (Hajee Mohammad Danesh Science and Technology University)*

Abstract: Sustainable solar energy solutions are made possible by the integration of lead-free perovskite materials with tandem structures, which offer a potential route toward increased stability, less environmental impact, and greater power conversion efficiency (PCE). By absorbing a larger range of the solar spectrum, tandem solar cells have surpassed the Shockley-Queisser efficiency limit and become a significant breakthrough in photovoltaic (PV) technology. This study investigates a new double-absorber tandem solar cell (SC) that uses SCAPS-1D modeling to maximize performance. It consists of a kesterite-based bottom cell (CZTSe) and a lead-free perovskite material called Caesium Titanium Bromide (Cs_2TiBr_6) as the top cell. To identify the ideal device configuration, the study methodically assesses various absorber and transport layer thicknesses, hole transport layers (HTLs), band alignment changes, parasitic resistances and temperature. Quantum efficiency (QE) and J-V characteristics confirm that the proposed double-absorber solar cell efficiently harnesses a broader solar spectrum while maintaining structural stability. Among the simulated configurations, the $FTO/TiO_2/Cs_2TiBr_6/CZTSe/Cu_2O/Ni$ structure demonstrates the highest photovoltaic performance, achieving a peak PCE of 27.18%. The device exhibits a short-circuit current density (JSC) of 42.457 mA/cm^2, open-circuit voltage (VOC) of 0.798 V, and fill factor (FF) of 80.26%, highlighting the superior charge transport and minimized recombination losses within the optimized architecture. This study underscores the potential of lead-free perovskite/kesterite tandem SC as a highly efficient and environmentally sustainable alternative to traditional silicon and lead-based perovskite devices. The findings provide valuable insights into optimizing device structure, material selection, and interface engineering to push the boundaries of PV performance.

An Improved Switched Inductor Switched Capacitor based High Gain Converter for EV Application

Lakshman Kumar Dangeti (Shri Vishnu Engineering College For Women); S M Padmaja (Shri Vishnu Engineering College for Women); Amritesh Kumar (National Institute of Technology, Silchar,Assam)*

Abstract: The growing demand for electric vehicles (EVs) necessitates sustainable and efficient charging solutions. Solar energy serves as an eco-friendly alternative to reduce reliance on conventional grids. This work introduces a high-gain, non-isolated Improved Switched Inductor Switched Capacitor (iSISC) converter to step up the low and fluctuating solar panel voltage to meet EV requirements. By integrating a switched inductor and switched capacitor configuration with two lower-rated switches, the converter minimizes current stress and enhances reliability. The design encompasses gain derivation, small-signal modeling, and parameter tuning for inductors and capacitors. Stability is improved through Lead Compensation, and comparative analysis with existing converters demonstrates superior performance. MATLAB/Simulink simulations for a 100W converter operating at 24V/144V validate the system's stability.

A Method for Detecting and Mitigating Steady-State DC Bias Current in Dual Active Bridge Converter

Sayantan Chowdhury (National Institute of Technology Silchar); A V V N Phanindra (National Institute of Technology Silchar); Amritesh Kumar (National Institute of Technology Silchar); Chayan Bhattacharjee (National Institute of Technology Silchar)*

Abstract: Dual Active Bridge (DAB) converters are widely used in various power transfer applications due to its several advantages like high power density, simple control methodologies, galvanic isolation,

soft switching and bidirectional power flow. However, the high-frequency transformer of the converter suffers from magnetic flux bias due to volt-sec imbalance both in steady state and transient state. The steady-state dc bias current (DCBC) in the DAB converter is generally caused by asymmetric switching of the power switches. So, to minimize the DCBC that appeared during steady state operation, this paper proposes a method to detect the dc offset current and actively minimize it by controlling the duty ratio of the power switches of the H-Bridges individually. In this paper, a DCBC detection algorithm is proposed which detects the dc offset current from the peak values of the leakage inductor current. The conditions for achieving zero dc bias current are derived from the small signal model. Two-stage control has been employed in order to minimize the DCBC and to restore the output power delivery which got hampered during DCBC minimization. Lastly, the proposed technique will be verified by the results of the simulation performed in MATLAB R2024a.

Design and Analysis of Novel Tristate Quasi-Z-Source Converter with Improved Dynamic Performance

Ashutosh Gupta (Delhi Technological University, Delhi); Dheeraj Joshi (Delhi Technological University, Delhi)*

Abstract: In this article, a novel fifth order two switch tristate quasi-Z-source boost converter (TQZBC) topology is proposed. It features a two-switch structure, a shared ground between load and source, low voltage stress and achieves high voltage gains corresponding to conventional DC-DC quasi-Z-source converters. With tristate configuration peak inductor current is reduced by incorporating a freewheeling interval through an simple switching control technique at the end of inductor charging state. Detailed examination involving steady-state and small-signal models is formulated for TQZBC and compared with those conventional boost converters, investigating various performance aspects. Simulations confirm the controller's performance in achieving regulation objectives. All theoretical findings are verified experimentally using TMS320F28379D DSP board for converter switching implementation and 240W, 48V to 120V TQZBC prototype is developed.

Bidirectional Power Flow Control in Triple Active Bridge Converters with Sensitivity Analysis

*Anand Panchbhai (NIT Silchar)**

Abstract: Triple Active Bridge (TAB) converters provide an efficient solution for multi-port power conversion, enabling simultaneous energy exchange among multiple sources and loads. Unlike conventional Dual Active Bridge (DAB) converters, which offer bidirectional power transfer but are limited to two ports, TAB converters enhance flexibility in applications such as renewable energy systems, electric vehicles, and aerospace power supplies by supporting multidirectional power flow. This paper presents an in-depth analysis of multi-directional power flow and sensitivity evaluation in a TAB converter, focusing on the impact of turns ratio and inductance variations on power transfer characteristics. Sensitivity analysis is conducted to quantify the influence of these variations on phase shift control, ensuring optimal power exchange under fluctuating operating conditions. A closed-loop power flow controller is developed to regulate power distribution across multiple ports. To validate the effectiveness of the proposed approach, a 3.5 kW system is carefully modeled in MATLAB/Simulink, demonstrating the robustness of the TAB converter in managing power flow across diverse operating conditions.

Design and Analysis of Multi-Input SEPIC DC-DC Converter for UAVs Charging Applications

Potnuru Sriramulanaidu (National Institute of Technology Silchar); Dhanavath Jeswanth (National Institute of Technology Silchar); Dunna Varma (NIT SILCHAR); Sayantan Chowdhury (National Institute of Technology Silchar); Phanindra A V V N (National Institute of Technology Silchar); Amritesh Kumar (National Institute of Technology Silchar)*

Abstract: This paper presents the design and analysis of a multi-input SEPIC DC-DC converter for UAV charging applications. The proposed converter integrates multiple power sources, including a unidirectional source (solar cell) and a bidirectional energy storage system (ESS) like a supercapacitor. The design ensures efficient power distribution, step-up/down capability, and reduced ripple current. A two-input configuration is analyzed, and simulation results validate the feasibility and effectiveness of the proposed converter.

Four-plate capacitive wireless power transfer using LCL-LCL compensation for electric vehicle charging application

*Parameswari M (Annauniversity)**

Abstract: Wireless power transfer, or WPT, is emerging as a promising approach of achieving efficient charging of electric vehicles. This study focuses on a four-plate capacitive wireless power transfer system that employs capacitive voltage mode control with an LCL-LCL compensation topology, aimed at enhancing the efficiency of power transmission and stability of transfer system. The kinetics outlined in the method relies on capacitive coupling for the wireless transmission of power, while the integrated LCL-LCL compensation network facilitates resonance, resulting in minimal power loss and stable voltages, even under varying load conditions. The system's performance is analyzed in relation to efficiency, power density, and suitability concerning EV charging. The simulation results proves that the proposed approach could assist as a valuable enhancement to the existing charging infrastructure for modern electric vehicles.

An Improved Methodology to Minimize Transient DC Bias Current in Dual Active Bridge Converter

Sayantan Chowdhury (National Institute of Technology Silchar); A V V N Phanindra (National Institute of Technology Silchar); Amritesh Kumar (National Institute of Technology Silchar); Chayan Bhattacharjee (National Institute of Technology Silchar)*

Abstract: Dual Active Bridge (DAB) converters are widely used in various power transfer applications due to its several advantages like high power density, simple control methodologies, galvanic isolation, soft switching and bidirectional power flow. However, the high-frequency transformer of the converter suffers from magnetic flux bias due to volt-sec imbalance both in steady state and transient state. This paper presents the effects of transient dc bias on a DAB converter with an approach to minimize it. The transient dc bias appears in the DAB converter due to sudden update of phase shift between two H-bridge pulses, load change, reversal of direction of power flow etc. So, to minimize the transient dc bias, a controller is implemented to detect the zero crossing of the leakage inductor current. The phase shift duty ratio is updated in steps during zero crossing of leakage inductor current to maintain average leakage inductor current to zero. The analysis and results of the proposed approach are verified by MATLAB 2024a.

Development and Simulation of a Dynamic Dual-Chamber Microbial Fuel Cell Model for Bioelectrochemical Energy Generation

Bitopan Baishya (National Institute of Technology Silchar); Kritika Das (National Institute of Technology Silchar); Vidhi Khakholia (National Institute of Technology Silchar); Amritesh Kumar (National Institute of Technology Silchar)*

Abstract: This paper presents the development and simulation of a dynamic microbial fuel cell (MFC) model using the Simulink software package. The model aims to provide accurate simulation of dynamic MFC behavior, enabling easy simulation platform integration. With a simple user-friendly Simulink block icon and Simulink libraries, the model permits simple analysis and simulation. Through

integration of vital dynamic factors such as substrate concentration, microbial performance, and electrochemical kinetics, the model permits the simulation and optimization of the MFC output voltage and power profiles. Here, we modelled the microbial growth and substrate consumption using the Monod equation. Further, we added another layer of realism by modelling the Mass Transport of the substrate in the anode by using Fick's First Law. Further by calculating the anode and cathode potentials and currents using the Nernst equation and the Buttler-Volmer equation respectively, the model reproduces the development of anode potential, cathode potential, and consequent output voltage and power profiles with respect to substrate concentration, temperature, and external loading. Simulation outputs prove that the model is able to successfully forecast the dynamic voltage, current and power curves of the MFC, yielding an effective means to optimize system design, control, and performance evaluation of energy systems based on MFC. This approach allows for comprehensive analysis of MFC system dynamics and facilitates the design and optimization of MFC-based energy systems.

Onboard EV Charger Using Totem-Pole PFC and Isolated DC/DC Converter for Enhanced Power Quality

Milan Sarmah (National Institute Of Technology , Silchar); Dhritiman Baishya (National Institute Of Technology , Silchar); Mukut Thakuria (National Institute Of Technology , Silchar); Prithvinil Das (National Institute Of Technology , Silchar); Amritesh Kumar (National Institute Of Technology , Silchar); Faridul Hassan (National Institute Of Technology , Silchar)*

Abstract: Efficient power conversion systems are essential for ensuring optimal performance in electric vehicle (EV) charging applications. Onboard EV chargers typically employ a two stage architecture, consisting of an AC-DC converter in the first stage and an isolated DC-DC converter in the second stage for battery charging. This work proposes a single-phase onboard EV charger through the integration of a totem-pole power factor correction (PFC) converter and a forward converter. The totem pole PFC converter is utilized for AC-DC conversion, while the forward converter provides DC-DC step-down regulation. To further improve power quality, a second-order generalized integrator (SOGI)-based controller is implemented, effectively reducing THD under distorted input voltage conditions. The operational principles of the proposed converter are analyzed, and simulation results are presented to validate its performance. The proposed PFC converter is simulated at a 1 kW power level with an 96 V output, aligning with the Bharat AC-001 standard for EV charging applications.

Recent Advances, Challenges and Future Prospects of Electric Vehicle (EV) Charging: A Technical Review

*Dr. Tushar Kanti Bera (NIT Durgapur)**

Abstract: The electric vehicles are driven by an electrical motor which runs with the electrical energy. The electrical energy is stored in a battery or battery bank and the electrical motor is run to drive the wheels to drag the vehicle. Due to the limited storage capacity of the battery, hybrid electric vehicles are also introduced by providing an alternate engine along with the electric motor in a single EV to ensure the long-distance driving. The adaptation of battery electric vehicles (BEVs) and plug-in-hybrid electric vehicles (PHEVs) are found exponentially increasing in the transportation system and hence are imposing a lot of power demand on the grid system for their charging process. This paper reviews the recent advances, challenges and future prospects of electric vehicle (EV) charging technology. The paper presents the technical aspects of BEV and PHEV technology along with the discussion on their components. The conducting charging, on-board charging, off-board charging, DC-fast charging processes are discussed. Battery charging levels, charging circuits and charging issues are summarised. Paper also discussed about the smart changing, battery swapping technology and charging locator. The prospect and challenges of wireless charging is also discussed followed by the recent advances in the WPT technology.

TRACK 2:

Modeling and Control of Energy Efficienct Drives for Electric Transportation (LAND, AIR AND SEA)

Development of the Dynamic Model of a Single-Stator Dual-Rotor Induction Machine

Susovan Mukhopadhyay (Netaji Subhash Engineering College); Sumita Sinha (Central Calcutta Polytechnic); Dipten Maiti (Jadavpur University); Sujit Biswas (St. Thomas College of Engineering and Technology); Soham Chakraborty (Netaji Subhash Engineering College); Gautam Poddar (IIT Kharagpur)*

Abstract: The modeling and simulation of a single-stator, dual-rotor induction machine having two rotors along the same axis and under a single stator frame is presented here, which is suitable for driving electric vehicles. A steady state model is established based on the equivalent circuit approach for simulating the machine performance under various operating conditions. A dynamic model in the d-q frame is proposed which will be useful for studying the transient behavior of this machine with different control arrangements and power converters so as to assess its application potential. Based on the experimental observations on a prototype 7.5 hp, 110 volt, 50 Hz, 4 pole machine having double cage rotors, the model is simulated taking into consideration the variation of magnetizing reactances and associated core losses. Rotor parameters are also assumed slip dependent in the simulated model to include the double cage rotor effect. The performance of the model has been verified by comparison between simulation and experimental results.

Seamless Grid-Compliant EV Charging Using DAB with EPS Modulation for Adaptive Current Control and Power Factor Correction

Shobhit Sharma (IIT Jodhpur); Nishant Kumar (IIT Jodhpur)*

Abstract: Achieving high power factor correction (PFC) under varying charging conditions is essential for the efficiency and grid compliance of electric vehicle (EV) chargers. This paper presents a three-phase EV charger that ensures seamless PFC across different charging demands. The system integrates a Vienna rectifier for front-end PFC and a Dual Active Full Bridge (DAFB) converter or Dual Active Bridge (DAB) for DC-DC conversion. The Vienna rectifier, controlled via pulse-width modulation (PWM), maintains near-unity power factor while minimizing harmonic distortion. To dynamically regulate charging current, the DAB converter utilizes Extended Phase Shift (EPS) modulation, enabling precise control over power transfer, improving soft-switching operation, and enhancing overall system efficiency. The charger operates in constant current (CC) mode, adapting to charging power levels ranging from 2.5 kW to 7.2 kW, with corresponding charging currents between 40 A and 64 A. Simulation results in MATLAB/Simulink validate the system's effectiveness, demonstrating high PFC performance, reduced switching losses, and stable charging behavior across different current profiles.

A Novel Interturn Fault Identification Solution for BLDC Motor Based EV System

*Tomeshvar Dhivar (NIT Raipur Chhattisgarh)**

Abstract: Electric vehicles (EV) are promoted highly in the present scenario to reduce carbon emission. Brushless DC motors are more adaptable in EV system as it offers high efficiency and consumes less power. Thus, for the safe and stable operation of EV system the healthy operation of BLDC motor. Due to several causes the BLDC motor can face several failures and thus identification of these faults on time is essential for the secure operation of EV. Among the various events interturn fault (ITF) is one of many failures. To identify this case, in this paper a novel technique is proposed. Voltage signals are used for fault identification. The method is tested for other critical conditions like with the presence of noise, under vibrations etc. this makes this method useful to other power train components.

A Novel Sensor-less Model Predictive Direct Torque Control for PMSM Using Sliding Mode and Adaptive Disturbance Observers

Great Tomar (National Institute of Technology Srinagar); Nishant Kumar (Indian Institute of Technology Jodhpur)*

Abstract: Sensor-less Model Predictive Direct Torque Control (MPDTC) scheme using a Sliding Mode Observer (SMO) for speed and electrical angle estimation and an Adaptive Disturbance Observer (ADO) for speed correction is presented in this paper. ADO and SMO are used with Space Vector Pulse Width Modulation (SVPWM) based Direct Torque Control Technique for improved accuracy. This proposed approach is implemented in MATLAB Simulink. Permanent Magnet Synchronous Motors (PMSMs) are widely used in electric vehicles and industrial applications because of their high efficiency and power density. The conventional Direct Torque Control (DTC) Technique is behind in high torque and high flux ripples. Model Predictive Direct Torque Control (MPDTC) helps to improve DTC by using optimal and constant switching frequency in real-time, thus decreasing ripples in Torque and Flux.

Efficient Sensorless Speed Control Techniques for BLDC Motors Using Back-EMF Zero-Crossing

Gudipati Jawahar Sagar (SRM Univeristy, Andhra Pradesh); choppa narasimha (SRM AP); Tarkeshwar Mahto (SRM AP); Somesh Vinayak Tewari (SRM AP)*

Abstract: Sensorless control of Brushless DC (BLDC) motors is a cost-effective and reliable alternative to traditional Hall sensor-based methods, eliminating the need for additional hardware while enhancing system robustness. This paper presents a robust closed-loop sensorless speed control strategy for a BLDC motor, integrating a Proportional-Integral (PI) controller with Zero-Crossing Detection (ZCD) of back-EMF. The proposed approach eliminates the need for position sensors by extracting rotor position information from the back-EMF of the unexcited phase and applying a 30° phase delay for precise commutation. A PI controller is implemented to regulate the motor speed by dynamically adjusting the Pulse Width Modulation (PWM) duty cycle of the Voltage Source Inverter (VSI) based on real-time speed error. The system, consisting of an AC rectifier, DC link capacitor, VSI, and BLDC motor, is modeled and simulated in MATLAB/Simulink. The proposed control strategy is further validated through real-time implementation using dSPACE, demonstrating stable speed control, fast dynamic response, and reduced steady-state error. The sensorless control method provides a cost-effective, efficient, and reliable solution, making it highly suitable for industrial automation, electric vehicles, and renewable energy applications

Rotor Flux Model Reference Adaptive System based Speed Estimation for Field-Oriented Control of Induction Motor Drives

Ambrish Devanshu (National Institute of Technology Silchar); Kosha Krishna Dutta (National Institute of Technology Silchar); Solemmi Hungyo (National Institute of Technology Silchar)*

Abstract: Induction motors (IMs) are widely used in industrial applications due to their robustness, low maintenance, and cost-effectiveness. Traditional methods rely on speed sensors, which increase system cost and complexity while reducing reliability. Sensorless speed estimation techniques have gained significant attention as they eliminate the need for physical sensors. Therefore, accurate speed estimation is crucial for the high-performance control of induction motor drives. This paper explores the principles, design, and implementation of rotor flux Model Reference Adaptive System (MRAS)-based speed estimation for Field-Oriented Control (FOC) of induction motor drives (IMD). The system's behaviour and response at low speeds and under load variations are analysed through MATLAB simulations. Additionally, a comparison between the proposed MRAS-based speed estimation technique and the conventional sensor-based method is presented, highlighting their advantages, challenges, and overall performance. Potential improvements for future applications are also discussed.

Fuzzy Logic Controlled 6-Phase PMSM Drive Under Various Operating Conditions

*Senthil Kumar Muthusamy (University of Technology and Applied Sciences); S K Mastan (Ramireddy Subbrami Reddy Engineering College); Nagaraja Rao S. (M S Ramaiah University of Applied Sciences); Sukhi Y (R.M.K. Engineering College); Sarishma Dangi (Graphic Era deemed to be university); Durgadevi G (New Prince Shri Bhavani College of Engineering and Technology); Chappidi Sreenivasa Rao (Vardhaman College of Engineering); Bhanu Prakash Kandi (ERG Foundation)**

Abstract: Six-phase permanent-magnet synchronous motor (PMSM) drives are utilized for various applications in various fields including electric vehicles, industries, agriculture, food technology etc. novel control methodologies must be implemented on six-phase PMSM drives to achieve better responses under various operating conditions. Hence Fuzzy Logic Controllers (FLCs) based speed control strategy is developed in this paper for regulating speed under various situations. The FLC attains a significant degree of dynamic performance by employing the vector control technique. Proposed FLC based Field-Oriented Control (FOC) is incorporated within the speed and current regulation mechanisms of the six-phase PMSM drives. The performance of the FLC based FOC with PMSM drives is evaluated through the design and simulation conducted in MATLAB, taking into accounts various operating conditions. The FOC exhibits enhanced resilience and efficiency in tackling the nonlinearity issues occurred in six-phase PMSM drive. The simulation results have validated the effectiveness of the proposed controllers.

Investigation on Different Magnet Geometries and Slot-Pole Combinations in Inner-Hollow Outer Rotor BLDC Motors for Yarn Feeding Textile Machinery

Surajit Saha (Indian Institute of Technology, Delhi); Abhishek Shaw (Indian Institute of Technology, Delhi); Amit Jain (Indian Institute of Technology, Delhi)*

Abstract: This paper investigates the design and performance analysis of a high-speed, low-power Brushless DC (BLDC) motor designed for two-for-one twisting yarn feeding applications in textile machinery. The study explores various stator slot-pole combinations and different permanent magnet shapes to optimize efficiency within a compact design. The proposed motor features both inner hollow and outer rotor configurations, ensuring high efficiency while addressing the spatial and performance constraints of modern textile machinery. Given the industry's demand for high-speed operation and energy efficiency, multiple magnet shapes and slot-pole configurations were tested to achieve maximum efficiency within the available space. The motor is capable of reaching speeds of up to 18,000 r/min, making it ideal for precise control in textile applications. Comprehensive simulations were conducted using ANSYS Maxwell and ANSYS Workbench to validate the design and performance. These analyses focused on key parameters such as magnetic flux distribution, torque, torque ripple, efficiency, and mechanical strength. Finally, a comparative study of different configurations is presented, with detailed analysis of the results to determine the most optimal motor design for textile machinery applications.

Performance Evaluation of Different Rotor Configurations in Brushless Permanent Magnet Motor for UAV Applications

Vaibhav Bhardwaj (Indian Institute of Technology Delhi); Durgesh Banchhor (Indian Institute of Technology Delhi): Amit Jain (Indian Institute of Technology Delhi)*

Abstract: This paper investigates the influence of different rotor configurations on the performance of an outer rotor brushless permanent magnet motor (OR-BPMM). A 2 kW OR-BPMM is designed using analytical equations, followed by a detailed evaluation through finite element method (FEM)-based simulations. Three rotor configurations are considered: Design I (arc-shaped permanent magnets with a cylindrical rotor back iron), Design II (rectangular-shaped permanent magnets with a cylindrical rotor back iron featuring a flattened base), and Design III (rectangular-shaped permanent magnets with a

cylindrical rotor back iron). The study examines key performance metrics, including torque, torque ripple, efficiency, weight, volume, manufacturing complexity. The comparative analysis provides valuable insights into the trade-offs associated with different rotor designs, facilitating the selection of an optimal configuration for improved motor performance.

Flux Observer-Based Position Sensorless Control of PMaSyRM for Light Electric Vehicles with Regenerative Braking

*Samyak Jain (Indian Institute of Technology Bhilai); Sushant Kumar (Indian Institute of Technology Bhilai); Shailendra Kumar (Indian Institute of Technology Bhilai)**

Abstract: This paper presents a flux observer-based control strategy for position estimation in a Permanent Magnet-Assisted Synchronous Reluctance Motor (PMaSyRM) and its application in Light Electric Vehicles (LEVs). The system operates based on reluctance torque and is driven by a three-phase Voltage Source Inverter (VSI). The motor's performance is enhanced using a Flux-based Sliding Mode Observer (FSMO). To mitigate chattering, the conventional signum function in the Sliding Mode Observer (SMO) is replaced with a hyperbolic function. The drive assembly is powered by a battery source through a bidirectional DC-DC converter (BDDC). This converter not only facilitates battery charging via a PV panel but also enables regenerative braking, thereby extending the vehicle's range, a critical factor for LEVs. The simulation and experimental results presented in this study cover various operating modes, including acceleration, braking, and regeneration. The findings validate the system's effectiveness, demonstrating improved speed and position tracking dynamics across different operational conditions, such as acceleration, regeneration, and rated speed operation.

TRACK 3:

Smart and Sustainable Charging Infrastructure for E-Mobility

A High-Efficiency EV Charging System with Interleaved Buck-Boost Converter and Adaptive Control

G. Jawahar Sagar (SRM University AP); V.Vivek Nag (SRM UNiversity AP); Tarkeshwar Mahto (SRM University AP); Sivamshu Nagalingam (SRM UNiversity AP); V Badrinath (SRM University AP); Pratikanta Mishra (SRM University AP)*

Abstract: Electric vehicle (EV) charging systems face critical challenges, including energy conversion inefficiencies, high voltage and current ripple, and instability under fluctuating grid conditions. These issues not only degrade performance but also shorten the lifespan of components and accelerate battery wear. Traditional charging systems often fail to address power quality concerns such as poor power factor and high total harmonic distortion (THD), which further exacerbate inefficiencies and negatively impact grid integration. This paper proposes a groundbreaking solution to these challenges by integrating a highefficiency single-phase AC-to-DC interleaved buck-boost converter with Adaptive Predictive PI-Fuzzy Power Factor Control (AP-PFC). By reducing ripple, improving thermal management, and optimizing power stage balancing, the interleaved buckboost converter significantly enhances efficiency and extends the lifespan of system components. The PFC stage ensures nearunity power factor, minimizes THD, and guarantees seamless grid integration. The hybrid PI-fuzzy controller adds real-time adaptability by dynamically adjusting PI gains based on key parameters like temperature, grid voltage, and battery state of charge (SOC), ensuring optimal performance under varying conditions. Furthermore, the MPC algorithm anticipates future system behavior, reducing energy losses and charging time while safeguarding battery health. Simulation results highlight the significant improvements in ripple reduction, charging efficiency, and battery longevity offered by the proposed system. This innovative approach presents a scalable, reliable, and adaptable solution that not only maximizes energy efficiency but also guarantees fast, secure, and sustainable EV charging, making it ideal for dynamic grid environments and next-generation EV charging infrastructure.

Peukert's Law Based Adaptive Control Strategy for EVs in VPP Based Energy Market

Subhajit Roy (National Institute of Technology, Silchar); Dulal Chandra Das (National Institute Of Technology, Silchar); Praveen Kumar (National Institute Of Technology, Silchar); Nivendu Nandy (Calcutta University); Kuntal Ghosh (Calcutta University); Nidul Sinha (National Institute Of Technology, Silchar)*

Abstract: The increasing integration of electric vehicles (EVs) into power grids presents new opportunities for enhancing energy efficiency and grid stability through vehicle-to-grid (V2G) and grid-to-vehicle (G2V) technologies. This paper proposes a Peukert's Law-based adaptive control strategy for optimizing bidirectional power transfer in a virtual power plant (VPP) network. The approach leverages fuzzy logic decision-making to dynamically regulate energy exchange based on grid demand, EV battery state-of-charge (SOC), and load conditions. By incorporating Peukert's Law into the control framework, the strategy accurately estimates battery discharge behavior, ensuring efficient energy utilization while minimizing degradation. A key aspect of this research is load balancing, where aggregated EVs actively support grid operations by strategically adjusting charging and discharging cycles. The control system integrates a bidirectional DC/DC converter model, constant current mode PI control, and a Peukert's Law-based time estimation method using the Levenberg-Marquardt algorithm. These components enable real-time decision-making to optimize energy transfer, prevent grid instability, and extend battery life. By implementing this adaptive strategy within a VPP-based network, the proposed method enhances grid resilience, reduces peak load stress, and facilitates greater penetration of renewable energy sources. The findings contribute to the development of smart energy management systems, enabling seamless integration of EVs as distributed energy resources. Future work will focus on refining optimization techniques and expanding the system's real-world applicability.

A Novel Adaptive Modulation Scheme for Reactive Power Minimization in Dual Active Bridge with Varying Load Demands

Shobhit Sharma (IIT Jodhpur); Nishant Kumar (IIT Jodhpur)*

Abstract: In electric vehicle (EV) charging stations, a bidirectional DC-DC converter act as a medium of power transfer between the charger and the EV. Among various isolated DC-DC converter dual active full bridge (DAFB) converter is predominently employed due to its high efficiency and galvanic isolation. To accommodate varying power demands, the DAB converter dynamically adjusts power transmission. However, efficiency declines under fluctuating load conditions due to increased reactive power.To mitigate this issue, a reactive power reduction approach utilizing triple phase shift (TPS) modulation is introduced. This method optimizes phase shift angles based on real-time power demand, improving efficiency and extending the soft-switching range. The effectiveness of the suggested method is validated by simulation results, which show a significant decrease in reactive power and improved performance over a broad power range, making it appropriate for EV charging applications.

Design and Simulation of EV Charger for wide Voltage range based on Phase shift full bridge DC-DC Converter

Vishaal S (SASTRA Deemed University); Jainth Vishnu Kumar M (SASTRA Deemed University); Arjun Rajendran (SASTRA Deemed University); Dr. Lenin Prakash S (SASTRA Deemed University)*

Abstract: Electric vehicle charging system is one of the crucial subsystems which plays a major role in the implementation and success of E-mobility system. The development of an on-board charger is one of the crucial tasks for an Original Equipment Manufacturer (OEM). For each and every new EV, it is required to design a new EV charger based on the battery capacity and voltage going through an entire new product development cycle of the charging system. It would be desirable to have a single hardware and firmware configurable charging system based on the different EV battery voltages, which would greatly minimize the development effort in terms of time and cost. However, most of the resonant topologies such as LLC converter which is one of the preferred topologies for an EV charger can not work for a wide range of voltage without compromising on the other performance indices such as efficiency and electromagnetic compatibility. The present work proposes an EV charger based on Phase Shift Full Bridge Topology for the isolated dc-dc converter stage preceded by a classic PFC boost rectifier stage. The design and simulation of the both the power stages has been presented. The proposed EV charging system has been validated by simulation for wide battery voltage range and it is expected to be an attractive solution for EV charger.

An IoT based Cloud Integrated State of Charge Estimation of battery Pack in SIMULINK Platform

Akshaya Pati (KIIT Deemed to be University); Tanisha Nayak (KIIT Deemed to be University); Madhbendu Rajguru (KIIT Deemed to be University); Komal Singh (KIIT Deemed to be University); sunil mishra (KIIT Deemed to be University); Avadh Pati (National Institute of Technology Silchar)*

Abstract: Battery Management Systems (BMSs) of an Electric Vehicle (EV) plays an important role to optimize the range performance and safety of the vehicle. To develop the BMS, an accurate measurement of battery terminal voltage, load current and also temperature parameters are required. In general, state of charge (SoC) is an estimated parameter from the measured values of battery voltage, load current, and temperature. So accurate estimation algorithm is required to estimate the battery performance parameters like SoC and state of health (SoH). Many estimation algorithms like extended Kalman filter(EKF), Machine learning based algorithms, and also some optimization algorithm are used. In all these algorithm, high computation and data storages are involved. In this work, a cloud based computation system is proposed to minimize the computation burden on the processor. Here, the real time data acquisition is carried out by the processor with suitable sensors and the processed data

stored in the real-time cloud environment. In this work, a MATLAB/SIMULINK cloud computing platform is used to compute the EKF algorithm to estimate the SoC in real time. A Raspeberry Pi 3B is used to send real time data to ThingSpeak cloud. The SoC parameter is also monitored in mobile APP.

Advanced Single-Stage on Grid Photovoltaic System for High-Efficiency DC Fast EV Charging Using SM-Sign NLMS Algorithm

Pavan Singh (Institute Of Engineering & Technology Lucknow); Bhim Singh (Indian Institute of Technology Delhi); Divyank Srivastava (Institute of Engineering & Technology Lucknow); Arunima Verma (Institute of Engineering & Technology Lucknow); Saurabh Mani Tripathi (Kamla Nehru Institute of Technology Sultanpur); Wazid Ali (Institute of Engineering & Technology Lucknow)*

Abstract: High-power-density charging stations are required for fast charging of electric vehicles (EVs), but their high and quickly varying power needs cause grid instability. This study suggests a unique way to facilitate rapid DC EV charging station while preserving grid voltage stability by integrating a photovoltaic (PV) system with grid using a voltage source converter (VSC). Because the system uses a single-stage PV VSC design, where VSC handles maximum power point tracking (MPPT), it does not require an intermediary boost converter. This study main innovation is the application of set membership sign-normalized least mean square (SM-Sign NLMS) control algorithm, which, when compared to conventional dq-based control strategies, greatly enhances VSC performance in terms of quick convergence, fewer oscillations, and improved grid synchronization. A dual active bridge (DAB) converter for EV charger is also included in suggested system architecture, guaranteeing high power density needed for quick charging. Power distribution to EV battery is optimized by DAB converter, which runs under constant current (CC) and constant voltage (CV) management. MATLAB/Simulink simulation results confirm system reliability, efficiency, and capacity to supply power to grid, non-linear loads, and EV charger while reducing voltage variations. For contemporary EV charging infrastructure, this study demonstrates how SMSign NLMS might improves grid-tied PV systems' performance.

Dual-Polarised Broadband Antenna for RF Energy Harvesting in 5G Applications

mamoni saha (nit silchar); Taimoor Khan (National Institute of Technology Silchar); Fazal A. Talukdar (National Institute of Tehcnology Silchar)*

Abstract: This article introduces a novel, compact broadband antenna design, fabricated on a low-cost FR4 Epoxy substrate with dimensions of 35×33×1.6 mm³. The proposed antenna features an elliptically tapered antipodal slot and a partial ground plane, enabling enhanced impedance matching and radiation characteristics. To achieve dual-band operation, covering the C-band satellite communication frequency range (3-5.8 GHz) and the upper WLAN frequency band (2.8 GHz), two distinct rectangular stubs are strategically integrated into the antenna radiator. A 50-Ω microstrip transmission line is employed for efficient excitation of the antenna. The simulated results demonstrate a peak gain of 3.3 dBi and 3 dBi at the resonant frequencies, indicating satisfactory radiation performance. A comparative analysis of the proposed antenna's performance with existing literature highlights its merits and potential applications.

Performance Assessment of Coil Structures for Wireless Charging in Underwater Vehicles

Sanghita Chakraborty (NIT Agartala); Ujjal Chakraborty (NIT Agartala); Padmagirisan Paramasivam (NIT Agartala); Shailendra Singh (NIT Agartala); Suman Murugesan (NIT Tiruchirappalli)*

Abstract: With the advancement of technology and innovation in the transportation sector, wireless power transmission systems have gained importance for charging infrastructure. Wireless charging efficiency relies on the air gap between the coils, compensation methods, and coil design. This paper

illustrates a comparative analysis of the different structures of the transmission and receiving coil in various mediums such as ferrite, air, fresh water and sea water, keeping the coil's number of turns and cross-section area constant. The performance of the coils is evaluated using finite element analysis (FEA) based simulation software, with a focus on underwater vehicles under seawater medium. The performance of parameters such as self-inductance of the coil, mutual inductance of the coil, magnetic flux density and coupling coefficient are compared. It is found that the circular-shaped coil provides better performance in comparison with other structures.

Design and Analysis of Charging and Discharging System for Electric Two-Wheeler

Devjyoti Sharma (National Institute of Technology Silchar); P Srinivasa Rao Nayak (National Institute of Technology Trichy)*

Abstract: With the rapid expansion of the electric vehicle (EV) market, efficient and flexible battery charging solutions are essential to enhance performance and adoption. This paper presents an advanced charging model for two-wheeler electric vehicles, incorporating three distinct charging modes: slow, medium, and fast. The proposed system utilizes a closed-loop control strategy to dynamically regulate charging speed, optimizing battery efficiency and longevity. The DC-DC buck converter with a current control loop incorporated with the system ensures precise charging current regulation, preventing overcharging and thermal stress on the battery. The model addresses key challenges such as long charging times, inefficient power conversion, and battery degradation by employing intelligent energy management. The complementary switching mechanism used in the system efficiently transitions between charging and propulsion states, ensuring uninterrupted vehicle operation. The system is validated through simulations, demonstrating reliable performance across different charging modes. The proposed model achieves an overall efficiency of 97.51%, minimizing energy losses and improving the longevity of two-wheeler EV batteries. This work contributes to the advancement of EV charging technology, promoting sustainable urban mobility and reducing reliance on fossil fuels.

TRACK 4:

Energy Conversion and Management for Sustainable Smart Energy Systems and Rural Electrification

Load Frequency Control of Hydro Power Plant Microgrid Integrated with Solar Farms and BESS Using Genetic Algorithms for PID Controller

Somila Hashunao (NERIST); Dr Ram Krishna Mehta (NERIST)*

Abstract: The growing demand for sustainable and reliable energy systems has sparked significant interest in microgrids as a solution for integrating renewable energy sources. Microgrids offer flexibility, resilience, and efficient management of energy resources. This study investigates the integration of a hydroelectric power plant, a solar photovoltaic (PV) system, and a battery energy storage system (BESS) to design a 5 MW microgrid, specifically targeting voltage and frequency regulation challenges while optimising efficiency and reliability. This paper investigates load frequency control (LFC) for a 5 MW microgrid comprising a hydroelectric power plant, solar photovoltaic (PV) system, and battery energy storage system (BESS). A PID controller, optimized using Genetic Algorithm (GA), is employed to enhance system performance under dynamic conditions. The GA optimization reduces frequency deviation to ±0.0015 pu, settling time to 6 seconds, and ensures voltage regulation within ±1% under varying load disturbances. The proposed system demonstrates efficient and stable operation, showcasing its potential for rural electrification, industrial power supply, and renewable energy integration.

AI-Enhanced Framework for Predicting Shading and Soiling Impacts in Photovoltaic Systems

Sonal S (Birla Institute of Technology, Mesra); Nilesh Rajalwal (Birla Institute of Technology, Mesra); Debomita Ghosh (Birla Institute of Technology, Mesra)*

Abstract: Photovoltaic systems offer cost-effective, sustainable energy, but partial shading and soiling significantly reduce efficiency, necessitating accurate shading prediction for optimized power output. Traditional energy management, reliant on human intuition, struggles with the complexity of modern energy optimization. This paper introduces an AI-driven energy management framework integrating computational intelligence, IoT monitoring, and deep learning to improve solar photovoltaic performance and energy storage. It addresses shading and soiling issues using EfficientNetB3, VGG16, ResNet50, and CNN models. Analysis of high-resolution images and performance metrics reveals nonlinear correlations affecting PV efficiency. The VGG16 model achieves 86.19% accuracy in anomaly detection, supporting predictive maintenance. A hardware-in-loop technique, using realtime feedback from the performance metrics of the most suited model, adjusts electrical parameters for optimal PV performance under soiling and shading conditions. This approach enhances energy efficiency thereby, contributing to smarter, sustainable cities.

Novel Target Loop-Based IMC-PID Control Law for LF Regulation in Power Systems

Dipjyoti Das (National Institute of Technology Silchar); Sudipta Chakraborty (National Institute of Technology Silchar); Md Nishat Anwar (National Institute of Technology patna); G. Lloyds Raja (National Institute of Technology patna)*

Abstract: This paper introduces a novel PID (proportional-integral-derivative) control approach aimed at regulating load frequency within power systems. Employing a target loop-based IMC (Internal Model Control) strategy, the PID controller is meticulously designed, focusing on time domain specifications. The formulation of this design specifically caters to a single area power system (SAPS). Through rigorous simulation using a model of a SAPS, the paper demonstrates the superior efficacy of the proposed method compared to existing approaches. Furthermore, the robustness of the method is assessed through simulations on a perturbed system, where process parameters experience a significant +50% variation. Finally, the paper concludes with a comprehensive performance summary, highlighting various performance errors.

Integrating PMU for fault analysis

*Manjeet Singh (Chandigarh University)**

Abstract: In present work explores power system dynamics using the PowerGUI model, focusing on normal and fault conditions. Key components include a three-phase source, V-I measurement, parallel RLC load, and optional Phasor Measurement Units (PMUs). The study analyzes normal operation, introduces PMUs for precision monitoring, and examines a three-phase fault scenario. The findings emphasize PMU advantages and applications, showcasing their transformative impact on grid management. In summary, this research provides insights into resilient power systems, emphasizing the crucial role of advanced monitoring tools

Identify the Net-Zero Emission Pathways through Cross-Border Power Interconnection in the BIMP Region

Pinto Anugrah (The University of Queensland); Rakibuzzaman Shah (Federation University Australia); N Mithulananthan (The University of Queensland); Md Rabiul Islam (University of Wollongong); Amritesh Kumar (National Institute of Technology Silchar)*

Abstract: Achieving net-zero emissions by 2050 is an important milestone for the ASEAN region, particularly the Brunei-Indonesia-Malaysia-Philippines (BIMP) region. This ambition requires strategic investments in cross-border power interconnection and renewable energy integration. To meet this, this paper examines the decarbonization potential of four scenarios: Fossil with CCS, Hydro-dominated, Solardominated, and Wind-dominated power grids. Each scenario will be compared by including and excluding the existing power development plan. This study used LEAP to model the power expansion plan from 2025 to 2050. Key parameters such as power generation mix, capacity addition, cumulative investment costs, and emission levels are analyzed. Results show that Hydro-dominated scenarios are the most cost-effective, requiring the least cumulative investment while achieving netzero emissions. On the other hand, Solar-dominated scenarios need the highest investments due to extensive capacity expansion. This study also found that CCS technology is less effective than renewable options to achieve net zero emission. The findings highlight the trade-offs among renewable energy pathways, emphasizing the role of hydro as a cornerstone technology while advocating for a diversified mix to enhance energy security and system resilience.

Direct method for evaluation of energy conversion efficiency in solenoid valves during start transient and improvements obtained by core annealing

Subrata Chakrabarti (Indian Space Research Organisation); Sidhartha PAV (Liquid Propulsion Systems Centre, ISRO.); Venkata Sunil Sai Nukala (Liquid Propulsion Systems Centre, ISRO.); Kodeeswaran M (Vikram Sarabhai Space Centre, ISRO); Aloke Kumar (Indian Institute of Science); Balaram Sahoo (Indian Institute of Science)*

Abstract: Energy Conversion efficiency in solenoid valves is an important subject of study considering its wide usage and application of such valves in the industry. In this paper we have attempted to present an analytical multi-physics based formulation which will help in deducing the energy conversion efficiency of solenoid valves in a direct manner without loss apportionment. We call our method as the 'flux augmention method'. We have studied the effect of opposing load, applied voltage and core annealing on energy conversion efficiency. The electromechanical transient characteristics (ETC) during valve opening is the focus of our study and analysis. We find that there exists an optimum voltage of operation at which the efficiency is at its highest. This optimum voltage of operation varies with actuator load. A maximum energy conversion efficiency of 37.5 % is noticed for the range under study and a maximum improvement of 10% could be obtained by annealing the soft magnetic core material. The valve should ideally be operated at the point of maximum energy conversion efficiency in order to be more efficient in the long run over its life span in pulse width modulation mode.

Design & Development of StaLoi-Meter: IoT-based Standby Load monitoring & estimation system for household

Abhranila Das (Synchro Electronics); Kumardeb Banerjee (Jadavpur University); Dipak Kumar Saha (Hoogly Institute of Technology)*

Abstract: People in modern society, especially in urban areas rely heavily on various appliances and electronic gadgets for daily necessities. These appliances and gadgets are typically controlled by a remote handset and usually left in an "always ON" state to ensure quick and efficient functionality. As a result, they often remain in standby/sleep mode for extended periods. While the power consumed in standby/sleep mode is relatively small at any given moment, it accumulates over time into a significant amount of wasted energy. This contributes to substantial energy loss and increased electricity costs for users. To validate this issue of power wastage, it is necessary to monitor standby power consumption continuously in an average household and generate a database for subsequent analysis. This paper proposes the design and prototyping of the StaLoi-meter, a portable, low-cost instrument that measures the supply voltage, current, and power consumption of any appliance that runs on mains supply and transmits the measurement data to a cloud server via Wi-Fi. Users can then access real-time power consumption data from anywhere through a cloud-based interface. The work also documents the usage of the instrument for power measurement of two typical electronic appliances and proposes necessary design augmentation to switch off power, as and when required, to minimize power wastage.

Control Strategy for Grid Tied Hybrid System with Improved Power Quality, while Switching between GTM and IAM

*Shashank Narayan (NIT warangal)**

Abstract: Microgrids are like mini power grids that can work independently or tied to the main grid. They use a mix of power sources like solar, BESS, and diesel generators, which can be directly connected to AC bus via inverters (Inverter-Based Resources or IBRs) or units like Diesel Generators (DGs). Microgrids are capable to operate both tied with to the grid and independently. In grid-forming, either the renewable energy source or the Diesel Generator controls the voltage and frequency, while the other manages power flow. To connect back to the main grid, a synchronization process is needed to prevent large power surges. This paper explains how to control the synchronization of an Inverter Based Resources (IBR) with the grid. It explains the operation of a hybrid energy system in both modes. It also shows how to control the Diesel Generator in grid-tied mode and proposes a method for smooth transitions between IAM and GTM. It also describes how a hybrid energy system operates in both modes. The system is validated in MATLAB/Simulink

Multi-layer Perceptron-Recurrent Neural Network VSC for EV Charging Stations with Integrated Renewable Energy Systems

Boda Anusha (Osmania University); P Satish Kumar (Osmania University, Hyderabad); Md Haseeb Khan (Muffakham Jah College of Engineering)*

Abstract: This article presents a comprehensive study on the application of Multilayer Perceptron-Recurrent Neural Network (MRNN) based vector control for Voltage Source Converters (VSC) in Electric Vehicle (EV) charging stations integrated with photovoltaic (PV) systems, wind generation systems, and battery storage systems. The primary objectives include improving power quality by mitigating harmonics and ensuring that the Total Harmonic Distortion (THD) of grid current remains within IEEE standards, even in the presence of nonlinear loads and fluctuating irradiance. Additionally, the paper focuses on reliable energy management by regulating the DC link voltage via the battery's bidirectional converter, thereby maintaining stable PV system operation and effective battery charging and discharging in both grid-connected and islanding modes. A model predictive direct current control (MPC) is proposed for the dc-dc converter of the EV charging station. The system's performance is

rigorously evaluated under dynamic conditions such as varying irradiance and wind speeds and maintaining system stability in real-world scenarios.

A High Gain Bidirectional Interlink DC-DC Converter to Integrate Unipolar and Bipolar DC Microgrids

RAGHAVENDRAN S (SRM institute of Science and Technology); Deepak Ram (Sastra university); Arun K (Sastra University)*

Abstract: In the era where energy efficiency and renewable integration are crucial, DC microgrid has emerged as essential, sustainable solution for modern power distribution. This paper introduces an interlink DC-DC converter designed to transfer energy between a low voltage unipolar and high voltage bipolar DC microgrid. The proposed converter features bidirectional buck-boost capabilities with high voltage transfer ratio. Furthermore, the converter acts as self-balanced voltage balancer which autonomously balances the voltage between the two poles of bipolar DC microgrid without requiring any auxiliary circuit or control requirement. Extensive design analysis and simulations are demonstrated to validate the performance of the proposed converter.

Real-time Health Monitoring Framework for Rooftop Solar Panels: Efficient, Reliable, & Cost-effective Solution

Nikhil Kumar (Student In IIT Ropar); Shivam Saini (Student In IIT Ropar); Aashish Kumar (Student In IIT Ropar); Anurag Patel (Student In IIT Ropar); K. Ramachandra Sekhar (IIT Ropar)*

Abstract: Solar energy, a sustainable and renewable resource, has gained significant traction worldwide due to its environmental benefits and technological advancements that have reduced costs, improved energy security, and enhanced competitiveness with conventional energy sources. The efficient performance and longevity of rooftop solar panel systems depend heavily on regular monitoring to detect and address issues such as shading, soiling, electrical faults, and environmental influences. This paper presents a reliable, cost-effective, and efficient system architecture for real-time health monitoring (RTHM) of rooftop solar panels, integrating both wired and wireless communication methods. A master-slave controller setup is employed, where slave controllers communicate with the master using one-wire communication, while Wi-Fi enables data transmission from the master controller to a cloud database server. This centralized approach ensures timely detection of system inefficiencies and faults, enabling proactive maintenance, minimizing downtime, and optimizing performance. The proposed system aims to improve the operational efficiency and lifespan of rooftop solar panels while offering a scalable and user-friendly solution for homeowners.

Comparison of Optimization Techniques for Energy Conversion and Management in Sustainable Smart Energy Systems

Sangeeta DebBarman (NIT Jamshedpur); Kumari Namrata (NIT Jamshedpur); Veerpratap Meena (NIT Jamshedpur); Kumaresh Pal (NIT Jamshedpur)*

Abstract: The transition toward sustainable energy systems necessitates efficient energy conversion and management strategies to optimize renewable energy utilization, reduce dependence on fossil fuels, and enhance grid stability. This study evaluates and compares three metaheuristic optimization algorithms—Particle Swarm Optimization (PSO), Grey Wolf Optimization (GWO), and Chimp Optimization Algorithm (ChOA)—for optimizing energy dispatch and management in smart energy systems. The optimization framework considers renewable energy sources (solar and wind), battery energy storage systems (BESS), and grid interactions to minimize energy losses and maximize renewable energy penetration. A MATLAB/SIMULINK-based simulation is conducted to analyze the performance of these algorithms in real-time energy scheduling scenarios. The results indicate that ChOA outperforms PSO and GWO in terms of convergence speed, renewable energy utilization, and

energy loss reduction, making it a promising technique for smart energy system optimization. The study highlights the significance of advanced optimization techniques in achieving a sustainable, resilient, and efficient energy infrastructure.

Assessment of Seasonal Variability for Resilience and Reliability Analysis of Grid Integrated Photovoltaic Systems for Energy Management

*Gyan Prakash Kashyap (N.I.T Uttarakhand); Arti Rani (N.I.T Uttarakhand); Manisha Prasad Singh (N.I.T Uttarakhand); Sonal S (Birla Institute of Technology, Mesra); Anant Khalkho (N.I.T Uttarakhand)**

Abstract: Photovoltaic systems play a crucial role in harnessing renewable solar energy, offering a sustainable solution to reduce reliance on fossil fuels and lower carbon emissions. This paper analyzes the seasonal variability of grid-integrated photovoltaic systems to assess resilience, reliability, and energy management efficiency. The study evaluates the loss of load expected across different seasons to measure system adequacy under fluctuating solar irradiance, electricity demand, and weather conditions. The study explores customer average interruption duration index, the system average interruption frequency index, and the system average interruption duration index, concerning the integration of solar power into the grid to ascertain its influence on the performance of the grid. Resilience grid dependency index is introduced to quantify the system's ability to recover from fluctuations resulting from seasonal variations in solar energy generation. Results highlight periods of increased grid stress, which serves as important parameter for efficient energy management system.

Energy Management System for DC Microgrid: Balancing Sustainability and Economics

Prashant Khare (National Institute of Technology Tiruchirappalli); Anurag Tripathi Tripathi (National Institute of Technology Tiruchirappalli); Abhinav Agrawal (National Institute of Technology Tiruchirappalli); Anuj Agrawal (National Institute of Technology Tiruchirappalli); Deep Maiti (National Institute of Technology Tiruchirappalli); Mallikarjuna Balimidi (National Institute of Technology Silchar); Jaya Bharata Reddy M (National Institute of Technology Tiruchirappalli)*

Abstract: This work is developing a centralized controller based energy management system (EMS) for a DC Microgrid. The Microgrid is modeled with one dispatchable source, one non-dispatchable source, and a Hybrid energy storage system (HESS). The function of the proposed EMS is based on power generation by the DERs, variable load profiles, state of charge (SoC) of the battery, and flag color of the electricity tariff. The proposed EMS is applicable in both Grid-connected and Islanded modes. In Islanded mode the EMS distributes the load demand among available DERs and HESS to make the power economic and utilize the dispatchable source to meet the critical load and enhance the reliability, in Grid-connected mode, the load demand is distributed among DERs, HESS, and Grid based on the Grid electricity tariff condition without any load curtailment. A supercapacitor is employed along with the battery in HESS to mitigate abrupt and unexpected battery stress. The proposed EMS for DC Microgrid benefits remote communities and industrial facilities. The complete model comprising DERs, HESS, Power electronic systems, and Control Strategy is developed using Simulink/ MATLAB.

Mismatch Current Extraction Technique Using Multi Input Single Output DC-DC Converter To Enhance The Performance Of The Partially Shaded Photovoltaic Array.

Pravin Murugesan (NIT Trichy); Senthil Kumar Subramaniam (NIT Trichy); Prince Winston David (Kamaraj College of Engineering and Technology); Aishwaya Fouzder (NIT Trichy)*

Abstract: Solar photovoltaic power generation is the promising clean energy source to power up the upcoming energy crisis. The major cause for the power loss in the solar PV array is ununiform

irradiation condition among the PV modules. The mismatching current caused due to the partial shading condition and limit the string and overall output current generated from the PV array. This proposed technique proposed to integrate a Multi Input Single Output (MISO) DC-DC converter to extract the mismatch current from the healthy module to balance the string current in the overall system. This mismatch current extraction technique will enhance the overall performance of the PV array by reducing the mismatching loss in the system. This proposed technique is tested and validated for the 90W capacity 3 × 3 solar PV array in the MATLAB/SIMULINK platform. The zero-mismatch loss can be for the testing shading scenario can be achieved. The 30% power loss also can be minimized when compared with the conventional configurations.

BIPV Based Community Microgrid Aggregation for Net Zero Energy Building

Ambarnath Banerji (Narula Institute of Technology); Abir Das (Narula Institute of Technology); Ranadip Pal (Adyapeath Annada Polytechnic College); Debabrata Bhaumik (Narula Institute of Technology); Srijan Saha (Narula Institute of Technology); Sufal Dhar (Narula Institute of Technology); Souvik Das (Narula Institute of Technology); Ankur Mondal (Narula Institute of Technology); Trisha Samanta (Narula Institute of Technology); Akash Banerjee (Narula Institute of Technology); Kamalika Banerjee (Narula Institute of Technology); Subimal Roy Barman (Narula Institute of Technology); Sudhangshu Sarkar (Narula Institute of Technology); Bansari Deb Majumder (Narula Institute of Technology); Sujit K. Biswas (St. Thomas' College of Engineering and Technology)*

Abstract: The pursuit of sustainable energy solutions has propelled the integration of photovoltaic (PV) systems into building designs. Building Integrated Photovoltaics (BIPV) and Building Attached Photovoltaics (BAPV) represent innovative approaches to harnessing solar energy while enhancing building functionality and aesthetics. This paper examines the contribution of BIPV technologies to energy sustainability by proposing the creation of Building Integrated microgrids (BIMG) using BIPVs. This will enable the BIPVs to efficiently cater to their local building loads, creating net-zero buildings. Each microgrid is managed by a microgrid controller (CM). For better energy management and to reduce the dependence of these microgrids on the utility grids, an aggregation of these microgrids into a community is further proposed. The energy management of the microgrid community is controlled by a community microgrid controller (CMC). The CMC communicates with the BIMG through a low-bandwidth data link. Each microgrid is linked to the community ac mains and the utility grid through an interlink controller. Any microgrid having excess power, possibly due to the shedding of its local load, is shared with the neighborhood microgrid in the community, over the community ac mains, and under the control of the CMC. This leads to the true Net Zero building community. A simulation of the BIMG connected to the Community ac mains is created to share the power during excess power generation. It validates the concept of the community microgrid using the BIMGs.

Performance Analysis of Grid-Forming Converters in Battery Energy Storage Systems for Large-Scale Solar/Wind Integration

Manjeet Singh (Chandigarh University); owais ahmad (chandigarh university)*

Abstract: Thorough examination has been done for grid-forming (GFM) converters in battery energy storage systems (BESS) with the sole purpose of integrating solar and wind energy sources on extensive scale. The research work highlights the advantages of GFM control strategies over traditional grid-following techniques, demonstrating how well they work to increase grid strength and stability while providing crucial rationale like fault ride-through capabilities and virtual inertia. The performance of GFM converters is evaluated under regular operating settings, emergency situations, and fault occurrences using extensive simulations that follow IEEE 2800 standards. The results demonstrate that the GFM enabled BESS may improve the overall flexibility and dependability of the power system while successfully addressing the intermittent nature of renewable energy. Also important insights into

the operating dynamics and stability-enhancing processes of GFM converters are drawn, highlighting their critical significance in future power systems with significant penetration of renewable energy.

A Novel Passive Islanding Detection Method Using DFIG Stator Flux

*Ankit Mishra (IIT BHU); Soumya Ranjan Mohanty (IIT BHU); Mitresh Kumar Verma (IIT BHU); Avirup Maulik (IIT BHU)**

Abstract: Unintentional islanding is a significant challenge in modern electrical power systems, jeopardising stability and safety. This paper proposes a new passive islanding detection method for a doubly fed induction generator-based wind generation system using four statistical features of the stator flux. The four statistical features are the kurtosis and skewness of the stator flux magnitude and the root mean square and mean of the rate of change of the d-axis component of the stator flux. Based on the simulation studies, specific thresholds of the statistical features can be established to effectively discriminate between islanding and non-islanding events. The proposed method also detects islanding under a perfectly power-matched condition. Simulation studies in MATLAB R2023a/SIMULINK validate the proposed approach.

Stability Analysis of a Solar PV Connected IEEE 33-Bus ON and OFF Grid Distribution Network

Arijit Ganguly (Brainware University); Dr. Ramesh Kumar (National Institute of Technology, Mizoram)*

Abstract: Overcurrent relays are used for protection in electrical networks operating at fault conditions. These are used for primary and backup protection, and they need to coordinate with switchgear. The stability analysis and reliability studies are performed on an IEEE 33-bus radial distribution system with optimal PV array allocation. The solar PV array makes the system reliable after isolation of grid due to fault on a bus. The whole system load may not be fed by PV array after grid isolation and system threats stability. A wise relay and circuit breaker operation disconnects industrial loads and keeps the system stable. The PV array will supply the rest of the system using Electrical Transient Analysis Programming (ETAP) simulation software.

Machine Learning Based Protection Strategy of Microgrid using Synchrophasor Measurement

Ambarnath Banerji (Narula Institute of Technology); Arpan Banerji (School of Electrical Science, IIT Bhubaneswar); Ayan Banerji (Dept. of Computer Science, IIIT Kottayam,); Sounak Biswas (M/s Catch Engineering Calgary, Canada.); Sujit K. Biswas (St. Thomas' College of Engineering & Technology)*

Abstract: Microgrid protection suffers from several challenges when conventional protection schemes of distribution networks are used. To overcome the challenges, an intelligent microgrid protection scheme using an explainable machine learning (ML) model is proposed by processing the reduction of positive sequence impedance and change of Angle related to the direction of active power flow. Phasor measurement units (PMU)s are used to collect the voltage and current data at the line ends. Microprocessor-based relays utilize this data from the PMUs to compute the change of positive sequence impedance and angle related to the direction of active power flow due to a perceived fault. Based on the above data, a decision tree (DT) is then used to identify the section of the microgrid where the fault has occurred. Further, measurement is made of Euclidean distance, over a three-cycle sliding window, between the rms value of the rated line current and the square of the instantaneous line current. This distance and the magnitude of the zero-sequence current are fed to the machine learning (ML) algorithm to classify the fault. Extensive data collection is done for different sections of a sample microgrid, for a fault at both upstream & downstream of the DGs connected, at different distances on a line and with different fault impedances.

Optimized Load Identification Using Total Harmonic Distortion and Artificial Bee Colony Algorithm

Pratyusha Biswas (Aliah); Pallav Dutta (Aliah University); Rumpa Saha (Aliah University)*

Abstract: Electrical energy plays a crucial role in modern innovation and is essential in today's world. Saving energy is a key priority, making efficient energy management in buildings are vital for reducing electricity usage. To achieve this, it's important to provide proprietors with clear information about the energy consumption of individual appliances. This requires breaking down the total energy consumption from a house's main circuits into separate devices. Identifying electrical loads helps to determine the type of appliance, its operating conditions, and its electricity usage. This article presents an improved method to identify devices within a network of interconnected household appliances. The suggested approach consists of two primary stages. First, instantaneous current signal is acquired from the simulated combined load. Using sample shifting technique (SST), load feature as total harmonic distortion (THD) of the combined load is calculated in Matlab environment. In second step, the individual loads connected to the power line are identified by the Artificial Bee Colony (ABC) optimization algorithm in Python environment. Various power metrices are determined to validate the identification accuracy. Simulations in Matlab environment are conducted to authenticate the proposed method.

A Radial Basis Function Neural Network-Based Fault Detection Scheme for a Microgrid System

Mamata Takhellambam (NIT Manipur); Manash kumar Mishra (NIT Manipur)*

Abstract: This paper presents a radial basis function neural network (RBFNN) based fault detection and classification scheme for a MG system. The proposed scheme processes eight inputs, including three-phase current and voltage, zero-sequence voltage, and current for the identification of faults in the MG system. The RBFNN is trained under various conditions such as line length, fault types, fault resistance, and ground resistance. Moreover, the trained RBFNN provides four binary outputs, indicating various fault types in the system with zero representing the absence and one denoting the presence of fault in each phase. The proposed RBFNN is trained using MATLAB to identify the symmetrical and unsymmetrical faults in the MG system. To evaluate the effectiveness of the proposed scheme, a comparison with conventional algorithms is performed in the detection and classification of various types of faults. The result demonstrates the reliability and superiority of the proposed fault detection scheme.

Load Reduction of a Wind Turbine Using H- Infinity based Individual Pitch Control

Abhinandan Routray (CVR College of Engineering); Debanjan Roy (Teerthanker Mahaveer University)*

Abstract: Wind turbines encounter significant unbalanced loads due to ensuing increases in their size and capacity. Wind turbines' lifespan would be shortened as a result. The individual pitch control (IPC) technology, which is well-known in wind turbines, is used to address this issue. IPC reduces the wind turbine's blade root bending moments (BRBMs) by reducing the tilt and yaw moments concurrently. In this paper, PI and H-infinity ($\boldsymbol{H}\infty$) based IPCs are discussed. Simulations are conducted using a 5 MW reference wind turbine from the National Renewable Energy Laboratory (NREL), which is implemented in the high fidelity aeroelastic simulation environment FAST. As per the IEC guidelines, varying wind speeds are used for the simulations. According to comparative findings, $\boldsymbol{H}\infty$ −IPC outperforms PI −IPC, CPC in terms of percentage of damage equivalent load and the reduction in BRBM.

NILM Scheme Enabled Wide Range of Electrical Load Identification using SST and SVM Techniques

Sarmistha Sengupta (The Calcutta Technical School); Rumpa Saha (Aliah University); Jitendranath Bera (Applied Physics Department, University of Calcutta)*

Abstract: The accurate electrical load identifications in residential sectors may help to implement type of use (TOU) tariff for better energy management in today's era of everincreasing demands of energy. For the different residential electrical loads, the sample values of the voltage and current signals are first acquired to generate various features using Sample Shifting Technique (SST). On these features Support Vector Machine (SVM) is applied to train and identify the loads. For different electrical home appliances having a wide range of power the proposed technique is applied, and loads are successfully identified. Various performance metric parameters determined to determine the accuracy of the proposed technique. A hardware based acquired data is used to verify the effectiveness of the proposed system.

Comparative Study of 6-sector and 9-sector DTC for Direct Drive-Wind Energy Conversion System

Sapam Rhison Singh (Ee, NIT Silchar); Lalit Chandra Saikia (NIT Silchar); Rukmi Dutta (Unsw Sydney); Aribam Deleena Devi (NIT Silchar)*

Abstract: This paper presents a comparative study on the performance of a Direct Drive Wind Energy Conversion System utilizing 6-sector and 9-sector Direct Torque Control (DTC) strategies. Due to its simplicity and quick response, DTC is a commonly used method for controlling Permanent Magnet Synchronous Generators that allows for independent control of the machine's torque and flux. However, the number of sector divisions in the DTC switching scheme significantly influences system performance, affecting torque ripple, power quality, and overall efficiency. In this study, a 9-sector DTC strategy is proposed and compared with the conventional 6-sector DTC to evaluate its impact on system performance. MATLAB/Simulink software is used to evaluate the performance of the proposed DTC under varying wind conditions. Simulation results demonstrate that the proposed 9-sector DTC improves system performance by reducing torque ripple, enhancing power quality, and increasing system stability. The additional sector divisions in the switching table enable finer control of torque and flux, leading to smoother operation. This study highlights the importance of optimizing DTC strategies to enhance the efficiency of wind energy conversion systems.

Adaptive Clustering for Distributed Load Management in Industrial Consumers: A Swarm-based Approach

*Neelofar Shaukat (COMSATS University Islamabad); Md. Rabiul Islam (University of Wollongong); Syed Ayaz Ali Shah (COMSATS University Islamabad); Jamil Ahmad Khan (COMSATS University Islamabad); Rakibuzzaman Shah (Federation University Australia)**

Abstract: This study presents a novel adaptive cluster concept for energy management and optimal energy distribution for industrial power systems to minimize load shedding and frequency regulation during grid disturbances. The proposed strategy dynamically forms clusters of industrial loads using data-driven optimization as a decision-making framework. Using a numerical optimization technique, a simulation-based analysis is conducted to evaluate the performance and assess the impact of adaptive cluster-based load-shedding on frequency stability. The results illustrate that the adaptive clustering concept improves resilience compared to independent load-shedding techniques and optimizes the load distribution while regulating the frequency response.

Ultra-High Voltage Gain Transformerless DC-DC Converter for Enhanced Renewable Energy Systems

*Muzammil Ahmed (Tezpur University); Anish Ahmad (Tezpur University)**

Abstract: Integrating renewable energy sources, such as solar photovoltaic systems, into DC microgrids requires DC-DC converters with high voltage gain due to the inherently low output voltage of these sources. Conventional converters, however, face significant challenges, including high voltage stress, limited gain, and issues with diode reverse recovery. To overcome these challenges, transformerless high step-up converters utilizing switched-capacitor and switched-inductor techniques have emerged as promising alternatives. This paper presents a groundbreaking ultra-high voltage gain DC-DC converter that combines an active switched-inductor with a switched-capacitor network. The proposed design achieves exceptional voltage gain even at lower duty cycles while minimizing voltage stress on the switching components. Unlike traditional converters, this solution enhances performance without introducing excessive circuit complexity. With improved voltage gain and reduced component stress, the converter offers a highly efficient and reliable solution for renewable energy systems. Comparative analysis is presented to validate its effectiveness. Finally, the operational and dynamic performance of the proposed converter is verified to confirm its functionality.

Comparison in enhancement of GMPPs and LMPPs for new Hybrid cross-tie BIPV arrays under Non-uniform Shading Patterns

Nikhil Arunrao Bodkhe (NIT Silchar); Debayan Sarkar (NIT Silchar); Risha Mal (IIT Guwahati)*

Abstract: Distributed solar photovoltaic (PV) and building-integrated photovoltaic (BIPV) systems have major obstacles in reaching the global maximum power point (GMPP) due to high and low non-uniform shading patterns (NU-SPs). Total Cross-Tied-Series Parallel-Total Cross-Tied (TCT-SP-TCT), Series Parallel-Total Cross-Tied-Series Parallel (SP-TCT-SP), Total Cross-Tied-Bridge Linked-Total Cross-Tied (TCT-BL-TCT), and Bridge Linked-Total Cross-Tied-Bridge Linked (BL-TCT-BL) are the four new hybrid BIPV array interconnections that are examined in this research study under high, low, and very low NU-SP conditions. Key metrics, including GMPP, open-circuit voltage (OCV), short-circuit current (SCC), and local maximum power points (LMPP1 & LMPP2) are analysed in a thorough performance review utilizing MATLAB R2023b simulations. Its sensitivity to shading is highlighted by the results, which show that TCT-BL-TCT consistently has the lowest GMPP and SP-TCT-SP consistently obtains the greatest. Multiple LMPPs emerge at varied irradiance levels, highlighting the importance of optimum connectivity schemes. The findings show that hybrid PV array topologies improve power extraction while mitigating the negative impacts of shade. Among the configurations, TCT-SP-TCT has better shade dispersion and higher LMPP values, making it an attractive option for efficient power generation. This study emphasizes the importance of strategic hybrid linkages in boosting energy yield and system stability under various shading situations.

A Comprehensive Design and Analysis of Solar PV Emulator

*Nallappagari Tulasi (NIT Tiruchirappalli); Divya S (NIT Tiruchirappalli); Kumaresan N. (NIT Tiruchirappalli)**

Abstract: The paper describes the development of modeling and simulation of a solar photovoltaic (PV) emulator. The PV emulator is a non-linear power supply with similar current-voltage (I-V) and power-voltage (P-V) characteristics of PV panels. It generates identical electrical behavior of solar PV cells based on the single-diode mathematical model. The proposed system supports the real-time generation of PV panel characteristics under different environmental conditions. The developed PV emulator comprises the PV model system, a buck converter, and a control strategy designed to generate the I-V and P-V characteristics. The output of this system is taken as the reference input to the controller, and the output of the buck converter gives the other input. These two inputs are controlled appropriately

using the PI controller. The operating point of the emulator is set by the control strategy based on the PV panel characteristics. This emulator system developed in this research integrates all the data based on the commercially available PV arrays. This approach provides a low-cost, portable PV emulator for the renewable energy sector. The successful operation of the proposed system has been confirmed with detailed simulation results for various operating conditions. The system is modeled and simulated using MATLAB/SIMULINK.

Resilient Power Synchronization in Tactical Military Bases using CARO tuned enhanced TID Controller

Smriti Jaiswal (National Institute of Technology Silchar); Dulal Chandra Das (National Institute of Technology Silchar); Amar Kumar Barik (Institute of Technology,Nirma University)*

Abstract: Energy security is inevitably crucial for modern military sites to prevent grid failures and cyberattacks. Microgrids, which combine essential facilities, energy storage, and renewable resources, have been put into place to address this. With a focus on standardized communication, dynamic reconfiguration, and strong cybersecurity, the Tactical Microgrid Standard, such as MIL-STD-3071, offers a framework designed to meet military requirements. Using Chaotic Artificial Rabbit Optimization (CARO), this work set up a sophisticated TIDA1 controller that is optimized for automatic load frequency management and power synchronization in military microgrid facilities. The microgrid model incorporates renewable energy sources from solar and wind energy systems as well as biodiesel and biogas units with the help of multiple energy storage systems. Instead, military electric vehicles are used for hybrid propulsion and energy consumption. The study assesses the range of TID controller variants tuned with different algorithms, including Particle Swarm Optimization, Artificial Rabbit Optimization, and Artificial Hummingbird Algorithm, together with CARO. The study demonstrates the comparative performance of traditional PID controllers and advanced TID controllers (TID, TIDA, and TIDA1) with aim to offer tactical military microgrids the stability and resilience.

Four port Bidirectional Converter with Sliding Mode Control for Hybrid Renewable Systems

*Somesh Lahiri Chakravarty (IIT (BHU)); Vineet Bharadwaj (IIT (BHU)); Kalpana Chaudhary (IIT (BHU))**

Abstract: This paper presents a comprehensive analysis of the control topology for a DC microgrid powered by a 2kW Photovoltaic (PV) array, a 2kW Proton Exchange Membrane Fuel Cell (PEMFC) stack, and a 25Ah battery pack. A four port DCDC converter is employed to integrate multiple energy sources efficiently, enabling flexible power flow management, reduced component count, and enhanced energy utilization compared to conventional single-input single-output (SI-SO) converters. A sliding mode-based controller (SMC) is implemented to regulate the switching of the PV-integrated and bidirectional ports of the converter, ensuring improved dynamic response, rapid transient recovery, and robustness against parameter variations. To evaluate system performance, a separately excited DC motor is used as the primary load, operating under different load torque conditions. The study examines various converter modes—Dual Input-Single Output (DI-SO), Single Input-Dual Output (SIDO), Triple Input-Single Output (TI-SO), and Dual Input-Dual Output (DI-DO)—demonstrating the adaptability of the four port converter and sliding mode control across different operating modes. MATLAB-Simulink simulations help assess both the adaptability of the proposed converter and the advantages of sliding mode control, validating the effectiveness of the proposed system.

Comparative Performance of PI and ANN Controllers for DTC of a PMSG-based Direct-Drive Wind Energy Conversion System

Aribam Deleena Devi (National Institute of Technology Silchar); Lalit Chandra Saikia (National Institute of Technology Silchar); Rukmi Dutta (UNSW Sydney); Sapam Rhison Singh (National Institute of Technology Silchar)*

Abstract: This paper presents an enhanced control strategy for direct torque control (DTC) in a wind energy conversion system (WECS) using a permanent magnet synchronous generator (PMSG). The conventional DTC scheme is improved by replacing proportional-integral (PI) controllers with artificial neural network (ANN)-based controllers. The PI controller parameters are first optimized using the artificial rabbits optimization (ARO) algorithm. In the proposed ANN-based DTC, the ARO-optimized PI controller is replaced with neural network-based regulators for more precise torque and flux control. A comparative analysis in MATLAB/Simulink shows that the ANN-based DTC achieves a torque ripple of 0.4735 Nm, compared to 0.5784 Nm for the ARO-optimized PI-based DTC. The flux ripple improves from 0.0178 Wb to 0.0056 Wb. The ANN-based DTC also provides better dynamic behavior and robustness to system parameter variations. This work demonstrates the potential of ANN-based controllers in improving DTC strategies for PMSGs, offering more robust and high-performance control systems for renewable energy applications.

Control and Modelling of PMSG-based Wind Turbine for integration to Conventional Grid

*Nischay Rana (Delhi Technological University)**

Abstract: This research paper shows the modelling of PMSG based wind turbine model and its control scheme. The machine side control uses Field oriented control (FOC) technique as an MPPT technique, to extract maximum power output from the wind turbine. The speed of wind is considered as a step function changing with time. Voltage-oriented control (VOC) is used at the grid side controller. The control and modelling have been performed on MATLAB/Simulink 2024a and results are taken to analyze the system performance and effectiveness.

A Coordinated Energy Management Control Scheme for a Grid-Integrated PV Hybrid Storage System

Mohd Sartaj Sheikh (Nit manipur); Manash Kumar Mishra (NIT MANIPUR)*

Abstract: Robust energy control has become very essential to maintain the grid stability and power quality as there is rapid rise in the growth of photovoltaic (PV) systems and the increasing dependence on hybrid energy storage This paper proposes an integrated energy management control scheme for a grid-interfaced PV hybrid energy storage system with battery energy storage and supercapacitors. The multi-layer control strategy proposed here optimizes power flow among the PV array, hybrid energy storage, and grid dynamically to efficiently suppress voltage oscillations, frequency deviations, and other power quality issues. Simulation studies under different loads and solar irradiances verify that the hybrid solution significantly enhances dynamic response as well as overall system reliability. Such findings substantiate that the hybrid storage solution not only improves power quality but also reduces grid stress and thus is a valuable candidate for advanced PV integration.

Integration of Pico Hydro Power System with PV based DC Microgrid

Jayadev Meher (NIT Rourkela); Krishna Roy (NIT Rourkela); Arnab Ghosh (NIT rourkela)*

Abstract: The integration of pico hydro power systems with photovoltaic (PV)-based DC microgrids provides an efficient and sustainable solution for decentralized energy generation, particularly in remote and off-grid areas. This paper explores the architecture, control strategies, and operational benefits of integrating pico hydro and PV systems within a DC microgrid system. The study highlights the maximum power point tracking (MPPT) through SEPIC converter for PV, integration of pico hydro generator through diode bridge rectifier fed buck (DBRB) converter, load-sharing between the sources and battery, and integration of energy storage element through bidirectional buck-boost converter for dc link voltage stability. Finaly a proportional and integral (PI) controller is designed to stabilize the dc link voltage and to ensure proper power distribution between the sources. The simulation of the proposed system is done on Matlab/Simulink software to validate the effectiveness of the system.

DC Bus Voltage Control in P&O MPPT based Wind-PMSG System using a DC-DC Bidirectional Converter with Storage System

Riju Nandi (NIT Rourkela); Arnab Ghosh (NIT Rourkela); Krishna Roy (NIT Rourkela)*

Abstract: This study focuses on developing a 5 kW wind energy conversion system with a battery, utilizing a bi-directional converter to deliver power to the grid and local loads efficiently. Maximizing power output while keeping the DC connection voltage constant in the face of wind variations is the most common issue with wind turbine systems. To keep the DC link voltage steady when operating independently, this study suggests operating a battery to store energy and a bidirectional buck-boost converter to control the charging and discharging processes back and forth. Getting the Maximum Power Point (MPP) of the wind energy system requires setting the boost converter's switching using the Perturbation and Observation algorithm. This study compares and contrasts PID with 2-DOF PID and 3-DOF PID. The responses of various controllers regarding controlled bidirectional DC-DC converters (BDC) are discussed here.

Demand Response based optimally modified fractional cascade controller in hybrid AGC incorporating EV.

Prabhat Vidyarthi (NIT Patna); Ashiwani Kumar (NIT Patna); Ravi Shankar (NIT Patna)*

Abstract: The purpose of the research is to examine how Automatic Generation Control (AGC) in a hybrid restructured power system reflects the intermittent nature of Renewable Energy Sources (RESs) with EV. The Demand Response (DR) is incorporating with hybrid AGC. In addition to two different energy sources thermal and bio plant in each control area, the power system under investigation includes verified real-time nonlinearities, such as boiler dynamics, Governor Dead Band (GDB), and Generation Rate Constraint (GRC). For both scheduled and unscheduled electricity under different contracts, such as poolco, bilateral transaction and contract violation transactions. Three controllers PID, TIDN, and 2DOF(FOPI)-TDN (proposed) are incorporated across a variety of power transform model. Furthermore, RESs like wind and solar power plants are proposed as case studies with random load. The effectiveness of proposed controller is compared with existing controller. To optimize the various gain parameters of the proposed controller, a modified version of the Quasi-Opposition based Crayfish Optimization Algorithm (QO-COA) technique has been proposed. Different results and case study analysis was conducted under poolco-based transactions to verify the suggested controller's resilience and adaptability. The IEEE-39 bus system is used to assess the suggested controller's resilience.

Enhanced Pitch Angle and Battery Charging Control for Standalone Wind Power Systems Feeding DC Loads

Devashish Jha (Madanapalle Institute of Technology and Science); Pranitha Mittapalli (Madanapalle Institute of Technology and Science); Anigani Reddy (Madanapalle Institute of Technology and Science); Roopendra Reddy (Madanapalle Institute of Technology and Science)*

Abstract: This study presents a control strategy for a standalone wind turbine designed to deliver maximum power to DC loads. The proposed approach utilizes a Maximum Power Point Tracking (MPPT) algorithm that dynamically adjusts to fluctuating wind speeds. Additionally, a robust load-balancing mechanism is employed to maintain a stable DC voltage, ensuring a reliable power supply to the DC loads despite variations in wind conditions. A dedicated control system continuously monitors and adjusts the operating parameters in real time to optimize performance.

Optimized Frequency-Modulated MPPT Strategy for Enhanced Performance of CL3C Resonant Converter in PV Systems

Shivam Saini (IIT Ropar); Aashish Kumar (IIT Ropar); A .Surya Kiran (IIT Ropar); K.Ramachandra Sekhar (IIT Ropar)*

Abstract: This paper introduces an advanced frequency modulated Maximum Power Point Tracking (MPPT) algorithm designed for a CL3C resonant DC-DC converter in photovoltaic (PV) systems. The CL3C topology stands out for its superior efficiency, higher power density, and better MPPT performance compared to traditional LLC and non-isolated converters like buck, boost, and buck-boost configurations. The proposed al gorithm dynamically fine-tunes the switching frequency in real time, enabling rapid and precise tracking of the maximum power point (MPP) while significantly reducing oscillations. Unlike conventional methods that rely on duty cycle modulation, this approach leverages frequency modulation, which is particularly effective for resonant converters. By enhancing the perturbation and observation (P&O) technique with adaptive step-size adjust ments, the algorithm addresses the common trade-off between tracking speed and steady-state oscillations. Simulation results confirm that the CL3C-based system outperforms both LLC and non-isolated topologies, delivering higher MPPT and overall conversion efficiency under diverse environmental conditions. This work underscores the potential of CL3C resonant converters to optimize solar power utilization, offering improved stability and energy efficiency in PV applications.

Neural Network Based Wind Estimation and Predictive Control for Wind Energy Optimization

*Abhinandan Routray (CVR College of Engineering)**

Abstract: Predictive control is a sophisticated control method that has demonstrated exceptional performance across a range of application areas. This study uses the linearized model of DNV-BLADED model of a 5 MW nonlinear Supergen (Sustainable Power Generation Supply) wind turbine in state-space form. This study uses a neural network (NN) based wind speed estimate approach to get precise and economical wind prediction needed for the feedforward model predictive control FF-MPC. The performance of the controllers is investigated by being applied to the full nonlinear Matlab/Simulink model of the same turbine at above rated NN estimated wind speeds. Then FF-MPC performance is compared with FB-MPC, feedforward-PI, and PI. According to the results, the FF-MPC performs better without requiring more control activity.

Efficient Solution of Multi-Period Three Phase OPF Problem Using Spatial Decomposition

Anup Parajuli (Washington State University); Nathan Gray (Washington State University); Subho Paul (Indian Institute of Technology (BHU) Varanasi); Anamika Dubey (Washington State University)*

Abstract: The optimized operation of unbalanced power distribution systems with battery-integrated distributed energy resources (DERs) requires the developing efficient multi-period three phase optimal power flow (OPF) techniques. To overcome the scalability challenges related to centralized solution strategy, distributed algorithms, especially the alternating direction method of multiplier (ADMM), are largely adopted to tackle three-phase OPF using spatial decomposition. However, ADMM a large number of macro-iterations, making it impractical for real-time decision-support. To overcome such deficiencies, in this article, quadratic objective linear programming (QOLP) based Equivalent Network Approximation (ENApp) algorithm is employed to achieve network level optimality by decomposing the centralized OPF problem into smaller sub-problems and solving each sub-problem in parallel by enabling boundary variable exchange between the neighbors. Performance evaluations on the IEEE 123-bus and 2752-bus test systems highlight the effectiveness of the proposed method, achieving substantial reductions in solution times when compared to both centralized and ADMM-based approaches.

A Design Oriented Dynamical Perspective on Proportional-Resonant Controller with 1-Φ Inverter

Aranya Bandyopadhyay (Indian Institute of Engineering Science and Technology, Shibpur); Kuntal Mandal (Universitat Rovira i Virgili); Sukanya Parui (Indian Institute of Engineering Science and Technology, Shibpur)*

Abstract: A combined Filippov-Floquet approach based rigorous analysis of a single phase inverter with proportional-resonant controller has been performed, which can detect onset of both slow- and fast-scale instability. Dynamics of resonant controller is similar to the integral component in proportional-integral controller as both induces slow-scale instability. Detailed parasitic switched nonlinear model has been derived in addition to the idealized non-parasitic switched nonlinear model. Resistive parasitic elements such as switch on-state resistance, equivalent series and dc resistance, within the power circuit cause delayed onset of slow-scale instability, while having negligible effect on onset of fast-scale instability. Inherent time delay arising in analog controller remains a nonsmooth slow-scale instability inducing phenomenon, causing earlier onset of slow-scale, while having negligible effect on fast-scale instability. Variation in switching frequency around the nominal value also causes earlier and delayed onset fast- and slow-scale instabilities at lower frequency. Thus, to what extent the analytically determined results shall deviate from the actual behavior depends on how all the phenomena are compensating or aggravating each other.

Solar Array-Energized, Battery-Interfaced Sensored PMBLDC Motor-Propelled Water Pump Utilizing an Enhanced Landsman DC-DC Converter

Ayush Purwar (NIT Silchar); Saheli Ray (NIT Silchar); Risha Mal (NIT Silchar)*

Abstract: This paper deals with a solar-driven water pumping system employing a permanent magnet brushless direct current motor (PMBLDC), powered by a solar array generation system (SAGS) to address the challenges of grid unavailability in remote rural areas. To achieve less complex and smooth motor operation, a sensored six-step 120° conduction-based trapezoidal electronic commutation scheme is implemented using a three-phase, two-level H-bridge voltage source inverter (VSI). Ensuring continuous and reliable pumping operation under varying climatic conditions, a Li-ion battery unit (LiBU) is integrated into the DC-bus, serving as an energy buffer support. For maximum power extraction from the SAGS, an enhanced Landsman DC-DC converter (ELDC) is deployed, controlled by an adaptively step-size adjustment (ASSA) based incremental conductance (INC) MPPT based switching control. This approach overcomes the steady-state error and misinterpretation of MPP caused by fixed step-size limitations, particularly during rapid irradiance fluctuations. The proposed system is modeled and simulated in MATLAB/Simulink (2018b version), and its performance is evaluated under two critical scenarios: rapidly varying solar irradiation and motor stalled operation. The results confirm stable DC-bus voltage regulation, demonstrating the robustness of the control strategy in ensuring consistent power delivery to the motor.

A Novel Resistance Switching Algorithm for Optimal Operation in Solar PV Systems

*Nikhil Kumar (NIT Tiruchirappalli); Divya S (NIT Tiruchirappalli); Kumaresan N. (NIT Tiruchirappalli)**

Abstract: The power generated from the solar PV panels has to be consumed/stored as and when it is available. So, an appropriate system and control algorithm for matching the load based on the environmental conditions must be implemented for effectively harvesting energy obtained from the solar PV system. In this regard, this paper presents a novel scheme for achieving Maximum Power Point (MPP) operation in Solar Photovoltaic (PV) systems using a Resistance Switching Algorithm (RSA). This approach simplifies the system design by employing a series of resistors switched according to consumer load requirements and environmental conditions. For this purpose, Resistance Switching Unit (RSU) has been designed and implemented along with RSA. Thus, the RSA provides a simple and effective way to track the MPP by adjusting the resistances in RSU. Solar irradiance is a vital factor in implementing the proposed RSA; the irradiance has been estimated using the PV panel voltage and current measurements and the parameters of the PV panel at standard test conditions. The mathematical modeling of the PV system and comprehensive design are presented. The proposed system has been implemented and tested using MATLAB/Simulink to demonstrate its effectiveness in maintaining

optimal power output. The results indicate that the proposed resistance switching strategy successfully tracks the MPP, providing a cost-effective and efficient operation of solar PV systems.

WL-QHTGM-Based Adaptive Control of Grid- Connected PV System for Solar Water Pumping with PMSM Drive

Wazid Ali (Institute Of Engineering & Technology Lucknow); Bhim Singh (Indian Institute Of Technology Delhi); Divyank Srivastava (Institute Of Engineering & Technology Lucknow); Arunima Verma (Institute Of Engineering & Technology Lucknow); Saurabh Mani Tripathi (Kamla Nehru Institute Of Technolgy Sultanpur)*

Abstract: This paper presents an efficient solar water pumping system that is driven by a permanent magnet synchronous motor (PMSM) drive with a grid-connected photovoltaic (PV) system. This system utilizes a voltage source converter (VSC) regulated by widely linear Quaternion Hyperbolic Tangent German-McClure (WL-QHTGM) algorithm to maintain stable power exchange among PV source, grid, and connected nonlinear loads incorporated at point of shared coupling. PMSM drive is connected to DC link with an intermediate voltage source inverter (VSI). MATLAB/Simulink is used to model and simulate this system at three critical operating conditions: variations in solar irradiation, unbalanced load conditions, and changes in PMSM reference speed. PMSM successfully maintains desired speed and torque in all scenarios, ensuring continuous and efficient water pumping. Furthermore,nonlinear load is fed stably, and WL-QHTGM algorithm effectively regulates power flow, maintaining smooth interaction among PV source, grid and connected loads. Results validate system capacity to maintain consistent performance across a range of operational scenarios, highlighting effectiveness of WL-QHTGM algorithm for VSC control and robustness of vector control for PMSM speed regulation.

Robust Strategy for AGC and AVR in Isolated Hydropower Plants

Akash Kumar Deep (National Institute of Technology Patna); Gautam Singh (National Institute of Technology Patna); Deepak Kumar (National Institute of Technology Patna); G Lloyds Raja (NIT Patna); Gagan Deep Meena (National Institute of Technology Patna); Sudipta Chakraborty (National Institute of Technology Patna)*

Abstract: Performance of automatic generation control (AGC) and automatic voltage regulation (AVR) of a hydropower system is susceptible to load perturbations and cyberattacks, such as false data injection (FDI), which can significantly disrupt both frequency and voltage control. However, very few works in litera- ture consider both AGC and AVR. Hence, this paper focuses on a robust AGC and AVR strategy deploying appropriate controllers. These controllers are of simple PID (for AGC) and PI (for AVR) type, analytically designed using the moments matching method. The single-tuning parameters of the aforementioned controllers are designed using the integral of time-weighted absolute error, computed from AGC and AVR loops. This simple and robust method enhances system resilience and ensures improved sta- bility under cyberthreat conditions compared to some existing analytical controller design methods.

Design and Implementation of Fuzzy Logic Control Strategy for PV-Battery Microgrid

Pranati Purohit (NIT Rourkela); Arnab Ghosh (NIT Rourkela); Pravat Kumar Ray (NIT Rourkela)*

Abstract: To address the needs of isolated off-grid DC loads, an effective energy management approach is required for microgrid integrated with renewable energy sources. This research introduces voltage and current controller strategy based on fuzzy logic for battery storage system in conjunction with a PV system for the purpose of energy management. The battery's power flow is controlled via a bidirectional buck-boost converter through a fuzzy logic controller. Energy management based on fuzzy logic is put forward and uses only 3 membership functions for voltage and current control technique. Optimizing the duty cycle of a dc-dc boost converter is the key to achieving maximum power point tracking (MPPT)

using the Perturb and Observe (P&O) method. Using a changing PV irradiation profile, the energy management system is substantiated in MATLAB model.

Agro-Microgrid Frequency Stabilization Using Puma Optimizer Tuned Virtual Synchronous Systems

Smriti Jaiswal (National Institute of Technology Silchar); Dulal Chandra Das (National Institute of Technology Silchar); Amar Kumar Barik (Institute of Technology, Nirma University Ahmedabad, India)*

Abstract: Maintaining frequency stability in an isolated agricultural microgrids is challenging due to the high penetration of inverter-based renewable energy sources and low system inertia. This paper presents a novel agro-microgrid model for remote areas that incorporates renewable energy sources, advanced energy storage systems, power electronics, and virtual synchronous system support. This integrated approach ensures the reliable supply of critical and essential loads in rural environments. Second, the study assesses the performance of a Fractional-Order TID controller optimized using multiple metaheuristic algorithms—namely Particle Swarm Optimization, Whale Optimizing Algorithm, and a novel Puma Optimization Algorithm to achieve robust power synchronization and effective frequency regulation. Further a comprehensive sensitivity analysis is conducted investigating the practical scenarios, providing valuable insights into system behavior and resilience under variable load conditions, including the effects of photovoltaic shading paving the way for improved energy management of microgrids in rural and isolated areas.

Design and Performance Comparison of Solar PV & PV/T Systems with Enhanced System Efficiency

*Ahraz Hassan Moon (National Institute Of Technology Srinagar, J&K); Asadur Rahman (National Institute Of Technology Srinagar)**

Abstract: This article provides the design and performance comparison of a solar photovoltaic-thermal (PV/T) system in contrast to a conventional solar photovoltaic (PV) system. The simulations are done using PVsyst software. The solar PV/T system combines photovoltaic and thermal technology to improve system efficiency. The comparative analyses for solar PV and PV/T systems are carried out for the geographical location of NIT Srinagar, Kashmir, India, having a latitude of 34.12170 North and a longitude of 74.83720 East. The simulative results demonstrate that the electrical performance of the presented solar PV/T system operating at an ambient temperature of 400C is similar to that of a conventional solar PV system operating at 250C. Thus, the results reflect that the solar PV/T system improves performance for a temperature difference of 150C. The well-known fact is that the solar PV system efficiency increases with the decrease in the operating temperature. The simulation results establish this fact and emphasize the improved performance of the solar PV/T system. A practical solar PV/T system stands installed at the NIT Srinagar campus. Further research will contribute to establishing these simulative results for the practical system.

Enhancement of Power Quality by Novel Control Method of Wind-AE-FC-BSS based Hybrid Microgrid under Faults on Distribution Lines

Kalaivanan C (Sona College of Technology); Manjunatha B. M. (Rajeev Gandhi Memorial College of Engineering and Technology); Nagaraja Rao S. (M S Ramaiah University of Applied Sciences); Burada rao (ERG Foundation); Pareshwar Prasad (Graphic Era Deemed to Be University); Thamizhkani B (New Prince Shri Bhavani College of Engineering and Technology); R Phani Vidyadhar (Vardhaman College of Engineering)*

Abstract: Standalone electrical power generation systems that harness wind energy are widely employed across various models in multiple locations. To maintain a balance of power within these

autonomous systems, the presence of batteries is crucial. Additionally, the combination of Electrolyzer and Fuel Cell (FC) has the potential to strengthen independent microgrid systems, leading to increased dependability and decreased overall expenses. Normally, a three-legged inverter is used to provide AC power to various loads including single and three phase load units. However, distribution power lines often experience faults. Therefore, it is crucial to implement suitable control techniques on both the AC and DC sides to uphold power quality across different operational conditions. To ensure its longevity, the turbine speed cannot be restored after a malfunction takes place. Consequently, an updated Maximum Power Point Tracker (MPPT) controller is employed to ensure the wind system operates effectively during faults occurring on the distribution lines. Additionally, a novel inverter control technique is introduced to restrict the current flow in the inverter legs during a fault condition. This study showcases the results of MATLAB-Simulink simulations to validate the proposed approach.

Design and Analysis of TSK Fuzzy Controllers based Grid Connected DFIG System for Improving Power Quality

*Rama Prasada Reddy M (G. Pullaiah College of Engineering and Technology); Cholleti Harish (Chaitanya Bharati Institute of Technology); Shobana D. (Panimalar Engineering College, Chennai); Sandeep Gupta (Graphic Era (Deemed to be University)); Upendra Aswal (Graphic Era Deemed to Be University); Dhilipkumar R (New Prince Shri Bhavani College of Engineering and Technology); Satish Kumar G A E (Vardhaman College of Engineering); Bhanu Prakash Kandi (ERG Foundation)**

Abstract: To meet the increasing demand for electricity and reduce dependence on fossil fuels, there is a persistent increase in the deployment of grid integrated renewable energy sources for electricity production. Doubly fed induction generators (DFIGs) are extensively utilized in wind turbines due to their capability to maintain a stable voltage and frequency, even in the face of fluctuating wind speeds impacting the turbine rotor. The incorporation of power electronic converters, along with suitable control systems, enables the DFIG to markedly improve the dynamic performance of the electrical network. The efficient management of power converters can be achieved by employing a range of structural designs and control algorithms. However, conventional controllers frequently encounter difficulties in maintaining optimal performance during swift variations in wind speed. This article presents a novel control methodology that employs Takagi-Sugeno-Kang (TSK) fuzzy controllers, designed to perform various functions in grid-connected DFIG systems. The effectiveness of the suggested control strategy has been assessed in relation to variations in frequency, voltage, wind speed, and reactive power load. OPAL-RT units are utilized in a Hardware-in-the-Loop (HIL) configuration to generate detailed outcomes and responses.

FOPID Controllers for Regulating Voltage of a Standalone SPV - Diesel Generator - Battery Bank based Power Supply System

Rama Prasada Reddy M (G.Pullaiah College of Engineering and Technology); Suresh Babu G (Chaitanya Bharathi Institute of Technology); Murali Krishna T (Chaitanya Bharati Institute of Technology); Burada rao (ERG Foundation); Ankita Nainwal (Graphic Era Deemed to Be University); Mahima M (New Prince Shri Bhavani College of Engineering and Technology); Satish Kumar G A E (Vardhaman College of Engineering)*

Abstract: Standalone power supply system relies on hybrid Solar Photovoltaic (SPV) system - Diesel Generator - Battery bank is famous and established at many places for various applications. However, consumption of diesel is a key factor on the efficiency and cost of the system. Hence, a novel control methodology is developed in this manuscript to reduce consumption of diesel and also maintain energy management system irrespective of variations in the system. The proposed methodology is also helps to improve the power quality for supplying quality power at the load bus. A stable dc-bus is established by connecting SPV system, battery bank via dc/dc bidirectional converter and input terminals of the inverter. In order to obtained accurate responses, Fractional Order PID (FOPID) controllers are utilized

in the proposed control methodology. Deloading action on SPV system is also implemented on proposed control methodology for effective operation under light load conditions. Additionally, an inverter with bidirectional power flow is contemplated between the point of common coupling (PCC) and the dc-bus to feed power at load bus while also facilitating battery charging from the diesel generator as needed. The new control strategies have been applied to dc and AC converters. Inverter control is utilized to ensure balanced three phase voltages at the PCC by regulating the currents produced by diesel generator when operating under unbalanced loads. Balancing the currents of diesel generators can assist in minimizing torque oscillations on the shaft, thereby enhancing the longevity of the equipment. The inverter control compensates for the demanding reactive power by loads, eliminating the need for diesel generator to provide it. This can lead to a decrease in diesel consumption. Results are presented through both MATLAB and RTDS to analyze proposed control methodology under various case studies.

Enhanced Performance of Triboelectric Nanogenerator for Martian Environment

*Vellanki Satheesh Babu (VITAP-University); Anumatla Raju (VITAP- University); Krishnasamy M (VIT-AP University)**

Abstract: In planetary exploration the significant weight of metal coils and permanent magnets, in addition to the initial costs. make it challenging to use standard electromagnetic generators. A possible substitute is a triboelectric nanogenerator that produces a lot of power per Mars. However, to evaluate the requirement for a reliable and steady power supply for Mars houses and interplanetary exploration missions, a Mars analog weather chamber is Simulated. The performance of the intended model may generally be analyzed with temperature, air composition, and pressure, and in this study, we focused solely on analyzing the effect of temperature on the performance of the designed device in the Mars environment. Thus, the newly designed generator increased the output voltage by an increase of more than 20 V. as compared to the outcomes of the experiment and their scientific implications. Mars has plenty of wind, powerful dust storms, and surface tremors, all of which are desirable mechanical sources for electrical energy conversion.

Power Control of Offshore Grid by Frequency Matching for a DFIG Wind Power Farm Connected HVDC System under Voltage Fluctuatations

Rashmi Ranjan Patra (NIT Silchar, Assam); Asha Rani M. A. (NIT Silchar, Assam)*

Abstract: The offshore wind farm is one of the green energy technologies for power production in remote areas. The effective medium of power transmission from the offshore to the far away shore grid of more than 50 Km is feasible only with the help of the HVDC link for economical purposes. This paper proposes a novel power control technique of an offshore DFIG wind power farm (ODWPF) by injection of mitigating current at the shore VSC station of an HVDC link along with constant voltage/frequency (V/f) operation at the auxiliary grid. The HVDC link connected offshore wind farm is equipped with a line commutated converter (LCC) at the sending end and a voltage source converter (VSC) at the end terminal. The offshore substation is operated at variable frequency and voltage, which allows the ODWPF to be operated at constant V/f operation. The speed of each turbine varies with respect to other turbines. The DFIG wind turbine can adjust the small variations in the wind speed, and thus the frequency at the offshore auxiliary grid can be controlled according to the HVDC system voltage and frequency. The complete system is simulated in the PSCAD/EMTDC environment.

Strengthening GMPP in Off-Grid BIPV Systems with Array Interconnections Coupled DC-DC Boost Converters Under Partial Shading

*Sweety Kumari (NIT Silchar); Lakshay Prakash (NIT Silchar); Md Rebji Alam (NIT Silchar); Sandeep Kumar (NIT Silchar) ;Prakash Nandan (NIT Silchar); Debayan Sarkar (NIT Silchar)**

Abstract: Building-integrated photovoltaic (BIPV) systems offer a sustainable and integrated method of producing renewable energy on-site. Nevertheless, partial shading brought on by external elements such as shadows from surrounding buildings or clouds results in several peaks in the power-voltage (P-V) curve, making it more difficult to locate the Global Maximum Power Point (GMPP) and causing large energy losses. The improvement of GMPP tracking in off-grid BIPV systems under shading patterns, including frame, centre, and diagonal shading, is examined in this research. Maximum Power Point Tracking (MPPT) algorithms, like Perturb and Observe (P&O) and Incremental Conductance (INC), are compared. In order to reduce shading impacts and boost system efficiency, various photovoltaic interconnection topologies are also examined and coupled, including Series-Parallel (SP), Total-Cross-Tied (TCT), and Quarter Tied (QT). The efficiency of the suggested techniques is shown by MATLAB/Simulink simulations, which show enhanced energy output, decreased power losses, and increased adaptability to changing environmental conditions. The broad use of BIPV technologies in green building practices and sustainable energy solutions is greatly aided by these developments.

TRACK 5:

Computational Intelligence, Cyber Security and IoT Applications for Energy Efficiency and Conservation

A Residual Dense Network Approach for False Data Injection Attack Localization in Power Grid

Sindhura Gupta (Netaji Subhash Engineering College); Prasun Sanki (Netaji Subhash Engineering College); Biswarup Ganguly (National Institute of Technology Silchar); Susovan Mukhopadhyay (Netaji Subhash Engineering College); Ambarnath Banerji (Narula Institute of Technology); Sujit Kumar Biswas (St. Thomas' College of Engineering and Technology)*

Abstract: False data injection attacks have emerged as a sensitive event in the smart power networks with the wide utilization of information and communication technology. This kind of cyber-physical attacks directly affects the various power system parameter measurements (such as bus voltage, bus phase angle, and power flow) and interrupts the system security, reliability and operations. Over the years, state estimation has been utilized majorly for detecting false data injection attack events. However, it is observed that attackers have managed to counterfeit the system-measured data and inject improper data into the power network, which results in vulnerabilities in system operations. Earlier research works mainly focus on false data injection event detection. Practically, the exact location should be identified to perform necessary actions to address such unwanted situations. Therefore, this paper presents a deep-learning-based approach, employing residual dense network (RDN) to address the proper detection of the exact location of the false injected data. This work is investigated considering the IEEE 14 bus data system. The prime objective to employ RDN is to fuse features via identity mapping. The obtained results suggest the superior performance of the proposed model compared to the other state-of-the-art methods.

Detection and mitigation of cyber threat in deregulated multi -area LFC with renewable source.

Prabhat Vidyarthi (NIT Patna); Ashiwani Kumar (NIT Patna)*

Abstract: The world's growing need for power and awareness of green energy have led to a rise in the use of renewable energy resources (RES). The hybrid power system (HPS) has reduced inertia as a consequence, which might lead to fluctuations in frequency and perhaps unstable operation. The load frequency control (LFC) in a microgrid is in charge of preserving the frequency-regulating capabilities. For LFC to utilize measurement data, it must first be detected at a remote power system point and then sent across a distance to the controller terminals. Microgrid systems are now more vulnerable to new cyber threats due to their hybridization, which highlights the urgent need for efficient cyber threat detection and mitigation technology. LFC is taken into account while doing cyber threat research. Cyber threat aimed targeting LFC might result in frequency variation and instability, which could have major consequences like blackouts. The communication network may be the target of threats and attacks. Finding possible risks and their sources that might result in insecure failure is the aim of the sensitivity analysis. A variety of threats, including as false data injection attack (FDIA), resonance threat, and denial of service (DoS), are investigated on a multi-source hybrid microgrid. This article implements many types of assaults, including DoS, FDIA, and resonance threat. This article also discusses the future of cyber threat in LFC and focuses on preventing cyber threat on HPS.

Novel Advanced biocatalyst optimization algorithm for power loss diminution and voltage stability enhancement

*Dr Lenin Kanagasabai (Prasad V. Potluri Siddhartha Institute of Technology)**

Abstract: Advanced Rhodophyta optimization (ARO) algorithm is applied for solving power loss reduction problem. Activities and physiognomies of Rhodophyta are scientifically defined in the Rhodophyta optimization algorithm. Projected algorithm start the examination procedure with arbitrary primary solutions. Through exploration and exploitation, examination will be conducted for finding the global optimal solution. The solution region will be completely examined in the exploration section. In the exploitation section, quality of the solution will be enriched through concentrated search in the

specific area in the examination region. Proper balancing should be maintained amongst the exploration and exploitation in the algorithm process. Movement of Rhodophyta colonies will be in spiral mode with reference to the ecological conditions. Energy level of the Rhodophyta colonies is directly proportional to the size. In the phase of acclimate procedure Rhodophyta colonies unable to progress adequately through spiral movement and the Rhodophyta colony which owns algal utmost hunger rate is considered in the procedure. Each Rhodophyta colony undergoes spiral movement up until its energy level is drained. In the evolutionary progression smallest colony will passage towards the biggest Rhodophyta colony. Attributes of Horseshoe bat optimization algorithm is combined with the procedure to heighten the exploitation of the process.

Estimation of Oil- Paper Insulation of Transformer using Optical Coherence Tomography: An Image Texture Feature- Based Analysis

Sounish Maiti (NIT Silchar); Biswarup Ganguly (NIT Silchar); Soumya Chatterjee (NIT Durgapur); Raju Poddar (BIT Mesra)*

Abstract: This article proposes an image texture feature based algorithm for determining the ageing of oil-impregnated paper insulation of power transformers through the analysis of subsurface structural images obtained via optical coherence tomography (OCT). OCT used in this paper is a non-invasive optical diagnostic technique used for in-vivo cross sectional imaging of paper insulation. In this research, fresh mineral oil, copper strips and kraft paper were used to prepare the oil-paper insulation samples emulating rea-life insulation of a power transformer. Following this, accelerated thermal ageing of oil paper insulation has been done by placing the samples inside a hot-air oven around 100°C for 200 hours and 400 hours, respectively. OCT based imaging of the samples have been done to capture subsurface microstructural phenomena showcasing degradation of oil-paper insulation under accelerated thermal ageing test. For texture-based feature analysis, local binary pattern and grey level co-occurrence matrix have been employed. Qualitative and quantitative analysis have been carried out to investigate the variation in aging performance and various features are determined to assess different aging states of oil-paper insulation. The outcome of the present research shows the productiveness of OCT based imaging technique, indicating its strong potential for condition assessment in oil- paper insulation in power industries.

Artificial Intelligence in Photovoltaics to Transform Solar Energy for Greater Efficiency and Scalability

Karuppansamy C (PPG Institute of Technology); Chinnadurrai CL (Bannari Amman Institute of Technology); Raja Rajeswari I (Adithya Institute of Technology); Ravindran S (KPR Institute of Engineering and Technology); Udaiyakumar S (Sri Ramakrishna Institute of Technology)*

Abstract: The integration of Artificial Intelligence (AI) into photovoltaic (PV) systems represents a transformative shift in the renewable energy landscape, offering unprecedented opportunities to enhance solar energy efficiency and scalability. This study explores the potential of integration of optimization technologies in optimizing photovoltaic performance, addressing challenges such as energy loss, inefficiencies in power conversion, and limitations in grid integration. Advanced machine learning algorithms are employed to predict solar irradiance, monitor system health, and enable real-time adaptive control, ensuring optimal energy generation under varying environmental conditions. Furthermore, AI-powered analytics streamline fault detection, maintenance scheduling, and energy forecasting, reducing operational costs and downtime. PV systems can achieve enhanced scalability through smarter grid integration and better energy storage management. This paper highlights key

applications, current advancements, and future directions in the photovoltaic sector, underscoring the pivotal role of AI in driving the transition toward sustainable and efficient solar energy systems.

Smart Energy allocation for Electric Vehicles using Predictive Modelling

Dr.I.Krishna Pavan (B.V.Raju Institute of Technology Narsapur); Kaustubh Lakshmi Narayanan (B V Raju Institute of Technology Narsapur); Kongoti Srujana (B V Raju Institute of Technology Narsapur); Gouraiahgari Sravya (B V Raju Institute of Technology Narsapur); Gadikoppula Akshitha (B V Raju Institute of Technology Narsapur)*

Abstract: Efficient energy allocation for electric vehicle (EV) charging is critical to optimize grid performance and enhance user satisfaction. In this research, we utilize historical EV charging data from urban networks to develop predictive models for smart energy allocation. By applying advanced machine learning algorithms, we establish correlations between past charging patterns and real-time demand, enabling accurate short-term energy demand forecasting. Performance metrics such as Root Mean Squared Error (RMSE) and R^2 Score are employed to evaluate model accuracy. Our findings reveal that Gradient Boosting techniques achieve superior accuracy, minimizing forecasting errors and ensuring balanced energy distribution. This approach supports both grid operators and EV users by enhancing charging efficiency and reducing energy waste.

An Enhanced Energy Conserving Sensor Scheduling Scheme for Wireless Sensor Networks

*Dr. Sunandita Debnath (IIIT Vadodara)**

Abstract: Energy optimization, maximizing coverage, and maintaining reliable network connectivity are critical challenges in densely deployed wireless sensor networks (WSNs), especially in unconventional environments like underwater underground sensor networks. Therefore, in such type of energy constrained WSNs, it is essential to minimize energy consumption by scheduling sensors with higher residual energy, while maximizing coverage and maintaining connectivity. This research work proposes optimization algorithms-based sleep-awake mechanisms to optimize performance in energy-constrained sensor networks. Using optimization techniques to periodically schedule sensors into sleep mode reduces redundancy, conserves energy, and extends network lifetime.

Machine Learning-Based Prediction of Distributed Solar Adoption

Busireddy Hemanth Kumar (Mohan Babu University, Tirupathi); Rangu Seshu Kumar (Vignan's Foundation for science technology and research); Mejanrao Sushma (Vignan's Foundation for science technology and research); Pratyusha Bhasam (ignan's Foundation for science technology and research); E Parimalasundar (Mohan Babu University)*

Abstract: The increasing adoption of distributed solar energy requires precise predictive models to evaluate deployment potential across diverse regions. This study leverages Random Forest, Support Vector Regression (SVR), and XGBoost to examine the key techno-economic drivers influencing solar adoption. Using a dataset derived from the NREL dGen model, data preprocessing techniques, including missing value imputation and feature engineering, were applied to extract critical indicators such as roof utilization, solar potential, and cost efficiency. To improve model accuracy, GridSearchCV was used for hyper-parameter tuning, and performance was evaluated using Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R^2 Score. The feature importance analysis identified solar potential as the key factor influencing adoption trends. The findings indicate that Random Forest and XGBoost perform better than SVR, achieving greater accuracy with fewer errors. The visualizations of error metrics and actual vs. predicted values offer clearer insights into model effectiveness and consistency. These findings highlight the effectiveness of machine learning methods in predicting solar adoption, offering useful insights for policymakers and industry professionals to enhance solar deployment strategies. Future studies could enhance predictive accuracy by incorporating

spatiotemporal variables and broader economic factors, allowing for a more comprehensive analysis of solar adoption trends.

Cloud-Based Energy Management In Residential and Commercial V2G Networked Microgrid

Somasundaram Periasamy (CEG, Anna University); Bharani Shankar Velmurugan (CEG, Anna University)*

Abstract: This paper proposes energy management in residential and commercial DC microgrids with Vehicle-to-grid energy exchange. Loads are monitored and controlled using a ThingSpeak cloud server, which generates control commands based on sensor inputs. The hardware system is designed using NodeMCU-ESP8266 and NodeMCU-ESP32 and manages load and sources within a home environment. The LabVIEW is used to demonstrate the control action for demand side management, while Sources like photovoltaic, electric vehicle batteries and the grid are optimized using a real-time price-based algorithm. The system was modelled in MATLAB/Simulink, and OPAL-RT simulates the real-time operation of a price-based electric vehicle battery management system to perform V2G operation.

Generative pretraining transformer based false data injection attack detection framework for DC Microgrid under uncertain operating condition

Alankrita Alankrita (National Institute of Technology Silchar); Avadh Pati (National Institute of Technology Silchar); Nabanita Adhikary (National Institute of Technology Silchar)*

Abstract: Traditional false data injection attack (FDIA) techniques typically rely on prediction-based models that forecast renewable energy source (RES) generation. This reliance leads to increased computational demands, added complexity, and greater uncertainty. Recent advancements in generative models with zero shot learning have provided alternatives to apply auto-regressive modeling to other domains. In this paper, Generative pretraining transformer (GPT) based model is adapted for current measurement forecasting. The choice of GPT is motivated by its ability to capture complex temporal dependencies in sequential data and leverage generative pretraining to model nonlinear patterns in historical measurements, while also handling unknown inputs more robustly, which is an area where traditional prediction models often struggle. The Forecasted values are compared with actual values based on a sample of past measurements, and any deviation past the tuneable threshold can be used for the detection of FDIA. Furthermore, the sample captures current trends and contextual information about system dynamics, enabling efficient prediction of future measurements even when current readings are corrupted by FDIA or exhibit high variability through zero-shot learning. Various scenarios were examined by incorporating FDIA while evaluating false positives and computational demands. Results indicated proposed framework provides good detection with less computational overhead and complexities.

A Hybrid Deep Learning Network for Grid-Connected Solar Panel Fault Detection

Prasun Sanki (Netaji Subhash Engineering College Kolkata); Sindhura Gupta (Nejaji Subhash Engineering College, Kolkata); Biswarup Ganguly (National Institute of Technology, Silchar); Pampa Sinha (Kalinga Institute of Industrial Technology, Bhubaneswar); Sujit K. Biswas (St. Thomas' College of Engineering and Technology, Kolkata); Debapriya Das (Indian Institute of Technology Kharagpur)*

Abstract: In recent decades, grid-connected solar power systems have gained enormous interest among industrialists and researchers. Further, the proper installation of these solar power systems and seamless operation require continuous maintenance to extract efficient and reliable power from these solar panels. In order to achieve efficient power, several power electronics devices as well as numerous control system units, are required. Sometimes, these major elements suffer from faults and operational degradation. Therefore, in this paper, a hybrid deep learning model has been incorporated, considering

the one-dimensional convolutional neural network (CNN) with a bidirectional long-short-term memory (LSTM) model to identify and locate the various types of faults in a grid-connected solar photovoltaic system. A comparative analysis is also presented with the available state-of-the-art methods to investigate the efficacy of the proposed method. Detailed observations indicate the superior performance of the proposed technique for addressing multiclass fault identification and classification. The proposed fault diagnosis technique could also be applied to other industrial systems for condition monitoring applications.

FedCNN: Federated Learning Framework Based CNN Model for Fault Classification in IEEE 30 Bus Transmission System

*Pavan Kumar Bais (National Institute of Technology Raipur); Narendra Londhe (National Institute of Technology Raipur)**

Abstract: Fault classification in multi-bus transmission lines with high precision and security is crucial for ensuring a reliable and stable power supply. Data-driven approaches have demonstrated significant potential in accurately diagnosing faults in transmission lines. However, traditional centralized machine learning-based methods require manual feature extraction, which is both labor-intensive and time-consuming. Additionally, these methods pose concerns regarding data privacy and security. Sharing data with other devices on a cloud server increases the risk of data leakage, while restricting data sharing may degrade training performance. In this paper, FedCNN: convolutional neural network based on federated learning framework is proposed for precise and secure fault classification in the IEEE 30 bus transmission system securely. The local client model is trained on raw local data and transmits the model weights to the central server on the global model for fault classification. Different configurations of fault resistance, inception angle, and locations are considered. A 90:10 train/test split technique has been used to split the local client data and fed to local model training and testing data fed to evaluate the global model, getting 85.30% accuracy, which shows robustness and reliability of the model. Furthermore, a real-time simulator OPAL-RT 4510 has been used for real-time validation, ensuring the feasibility of deploying the proposed model in practical applications.

A Cost-Effective Driver Drowsiness Detection Using Embedded Vision Systems using Raspberry Pi for Enhanced Road Safety

Tasardhik Basha Shaik (National Institute of Technology); Dhruv Bajoria (National Institute of Technology Silchar); Nishi Sekhani (National Institute of Technology Silchar); Arkadeep Kashyap (National Institute of Technology Silchar); Risha Mal (Indian Institute of Technology Guwahati); Saurabh Chaudhury (National Institute of Technology Silchar)*

Abstract: Driver drowsiness is a critical contributor to road accidents globally, with significant fatalities reported in India due to sleep-deprived driving. This paper presents a cost-effective, real-time drowsiness detection system leveraging computer vision and hardware integration to enhance road safety. The proposed system employs the Eye Aspect Ratio (EAR), computed using facial landmarks detected via the Dlib library and OpenCV. EAR thresholds categorize driver states into active, drowsy, and sleepy, triggering visual alerts (LEDs) and auditory alarms (buzzer) for timely intervention. Experimental results demonstrated 96% accuracy under normal conditions, though performance dipped to 76% in dim lighting or with glasses. Comparative analysis highlighted the efficacy of real-time processing, portability, cost-effectiveness, and seamless integration. The system's non-intrusive design, reliance on affordable hardware, and modular architecture make it scalable for vehicular deployment. This study underscores the potential of EAR-based drowsiness detection systems to mitigate accidents caused by fatigue, offering a pragmatic solution for improving road safety in resource-constrained settings.

Cyber-Induced Voltage Deviation Detection and Mitigation in DC Microgrids Under Operational Constraints

*Tushita Das (IIT (ISM) Dhanbad); Mitikiri sagar Babu (IIT (ISM) Dhanbad); Pranay Krishna Sahay (IIT (ISM) Dhanbad); Vedantham Lakshmi Srinivas (IIT (ISM) Dhanbad)**

Abstract: DC microgrids operate under a hierarchical control strategy that relies on communication-based layers for effective power management. However, the integration of digital controllers and communication networks makes them vulnerable to cyber threats, particularly False Data Injection Attacks (FDIAs). These attacks manipulate sensor data, leading to incorrect control actions that can cause voltage deviations, excessive current draw, or even system failure. This paper proposes a Fault Data Detection and Mitigation (FDDM) control strategy to detect and counteract cyber-induced voltage deviations in DC microgrids. The method leverages system constraints and real-time voltage monitoring of neighboring buses to identify and mitigate FDIAs. By analyzing voltage deviations and error signals, FDDM ensures that bus voltages remain within safe operational limits, preventing disruptions in duty cycle control. The proposed approach is validated through MATLAB/Simulink simulations under various load variations, cyberattack scenarios, and system constraints. The results demonstrate the effectiveness of FDDM in maintaining system stability, ensuring secure operation, and mitigating the impact of cyber threats on DC microgrids.

A Comparative Study of Transformers based Machine Learning Models for Solar PV Power Forecasting

Dileep G (Jigme Namgyel Engineering College, Bhutan); Sreenu Sreekumar (NIT Silchar)*

Abstract: Precise solar power forecasting is essential for ensuring optimal power quality and system dependability due to the growing integration of photovoltaic (PV) facilities into power systems. The intermittent and unpredictable nature of PV power poses a substantial problem for system operators when it comes to successfully managing and distributing power from PV power stations. Conventional models commonly rely on meteorological data to accurately predict PV power generation in the day ahead. Nevertheless, these forecasts frequently prove inaccurate during severe weather conditions. In this paper, the effectiveness of novel time series forecasting methods, including Temporal Convolutional Mixers (TCMix), Decomposition Linear (DLinear), and a hybrid of these two, for short-term and long-term solar power forecasting is evaluated. The projected outcomes from the suggested photovoltaic power forecasting model closely correspond with the recorded measurement data. Moreover, this model showcases enhanced prediction precision in contrast to conventional approaches that employ artificial neural networks (ANN).

Acoustic Partial Discharge Signal Denoising using a Residual Convolutional Neural Network

*Chandan Kumar (NIT Mizoram)**

Abstract: Partial discharge monitoring is a crucial diagnostic tool for assessing insulation health in high-voltage power equipment. However, effective PD detection is often hindered by noise contamination, including repetitive pulse-shaped noise, discrete spectral interferences, and broadband white noise. Traditional denoising techniques, such as wavelet transform (WT), empirical mode decomposition (EMD), and singular value decomposition (SVD), struggle with maintaining signal integrity while effectively removing noise. In this study, a novel Residual Convolutional Neural Network (R-CNN) is proposed for acoustic PD signal denoising. The model leverages residual learning principles to predict and subtract noise components while preserving critical PD features. Experimental validation is conducted using acoustic PD signals collected from a transformer-based experimental setup. The proposed Residual-CNN is evaluated against conventional methods, including SVD and Variational Mode Decomposition (VMD), under different signal-to-noise ratio (SNR) conditions. Performance metrics, such as SNR improvement, root mean square error (RMSE), and noise reduction level Rnl, demonstrate that the R-CNN significantly enhances denoising effectiveness. The results

highlight the model's superior ability to reconstruct noisy PD signals, making it a promising solution for real-time PD monitoring in power transformers.

Harris Hawks Optimized Regulated Frequency in Thermal, Hydro, and Solar Integrated Power System

Souvik Dutta (National Institute of Technology Durgapur); Alpana Barman (National Institute of Technology Durgapur); Aashish Bohre (National Institute of Technology (NIT) Durgapur, WB); Omkar Yadav (National Institute of Technology Durgapur); Parimal Acharjee (National Institute of Technology Durgapur)*

Abstract: Maintaining frequency stability is critical for the reliable operation of modern power systems. Frequency regulation ensures system balance by dynamically adjusting power generation in response to load variations. This study investigates a two-area frequency regulation system incorporating thermal, hydro, and solar power plants to enhance system stability and efficiency. The thermal power plant ensures a steady power supply but exhibits slower dynamic response due to inherent governor and turbine delays. The hydro plant, a renewable energy source with moderate response time, is affected by water start-up delays. Solar power, despite its intermittency, reduces carbon emissions and contributes to a cleaner energy mix. Integrating these diverse sources in a multi-area system requires an intelligent control strategy to mitigate frequency deviations and maintain balanced power exchange. A mathematical model of the two-area frequency regulation system is developed, incorporating the detailed dynamics of each power source. The governor-turbine models of thermal and hydro plants are integrated with the solar generation system. To optimize the system, advanced metaheuristic algorithms such as Particle Swarm Optimization (PSO) and Harris Hawks Optimization (HHO) are employed to fine-tune the Proportional-Integral-Derivative (PID) controller parameters for improved frequency stability. MATLAB Simulink simulations validate the proposed approach, demonstrating superior frequency regulation, reduced settling time, and minimized deviations under varying load conditions. The findings indicate that hybrid integration of thermal, hydro, and solar energy enhances system resilience against load variations and renewable energy fluctuations. This study underscores the significance of multi-source coordination in modern power grids and provides a foundation for future advancements in renewable-integrated frequency regulation systems.

TRACK 6:

Automation, Control and Digitisation for Industry Applications

Induction Motors with Variable Frequency Drives: A Systematic Review with Focus on Health Monitoring

Priyabrata Shaw (GE Vernova); Nikhil Kumar Sharma (GE Vernova); Bibhudatta Patnaik (GE Vernova)*

Abstract: Induction motors (IMs) with variable frequency drives (VFDs) are widely used in various industrial applications, including heating, ventilation, and air conditioning (HVAC) systems, pumps, fans, chillers, and air handling units (AHUs), due to their cost-effectiveness, robust performance, enhanced energy efficiency, and low maintenance needs. Therefore, monitoring the health of IM drives is crucial to minimize system failures and enhance the reliability of motor drive systems. This paper provides a comprehensive review of the different failures in IMs and VFDs, along with the available health monitoring techniques. Moreover, it discusses the standard VFD architecture and its control mechanism for IM. This paper then details the most common failure modes in IMs and VFDs, along with the existing diagnostic methods for these failures. Additionally, it examines the key benefits and limitations of traditional health monitoring schemes and presents a comparative study of these reported methods.

Development of Agriculture Monitoring System for Eggplant Crop using Unmanned Aerial Vehicle

*Anurag Chauhan (Rajkiya Engineering College Banda, Uttar Pradesh)**

Abstract: In the current scenario, different types of plant is main source to meet the food needs of the world. However, unfavourable environmental conditions affect the crop health and crop production. Therefore, state of the art methods are required for the early detection of crop diseases to raise the production. Under the current work, a convolutional neural concept based ResNet-50 classifier is developed for the early prediction of various diseases in eggplant crop. Image dataset of unhealthy/healthy crop leaves were collected by using Unmanned Aerial Vehicle (UAV). Four diseases of the eggplant crop are considered during the development of classifier i.e. cercospora melongenae, lace bug, leaf curl and pest. Further, health condition of the crop is examined by using first classifier. While, second classifier is developed to detect the diseases of eggplant crop. Finally, accuracy and precision of the developed classifiers have been estimated on the basis of several performance metrics.

Second-order Sliding Mode Load Frequency Control of Interconnected Power System

Pritom Aich (Daffodil International University); Anis Ahmed (Khulna University of Engineering & Technology); Rakibuzzaman Shah (Federation University Australia); Majed Majed (Khulna University of Engineering & Technology); Md Rabiul Islam (University of Wollongong); Amirtesh Kumar (National Institute of Technology Silchar)*

Abstract: Load frequency control (LFC) in interconnected power systems is critical, as it can lead to frequency instability and compromise overall system stability. By effectively controlling tie-line power between interconnected areas, this challenge can be addressed. This paper presents the design and implementation of a second-order sliding mode control (SOSMC) approach for LFC in an interconnected two-area power system, demonstrating its performance in mitigating frequency deviations and achieving minimal steady-state error. Simulation results confirm that the proposed SOSMC outperforms conventional sliding mode controllers (SMC) and PID controllers with respect to enhanced damping characteristics, reduced chattering, and improved robustness across various loading conditions. These findings position SOSMC as a highly effective and reliable control strategy for maintaining tie-line power balance and ensuring frequency stability in interconnected power systems.

An Uniform Wideband High-Frequency Current Transformer for Measurement of Partial Discharges in High Voltage Power Apparatus

Piklu Das (NIT Durgapur); Soumya Chatterjee (National Institute of Technology Durgapur); Chiranjib Koley (NIT Durgapur)*

Abstract: In this paper, a novel inductive sensor solution for partial discharge (PD) measurement in high voltage equipment is proposed. The developed sensor is a low-cost high frequency current transformer (HFCT) which has been developed in the laboratory for measurement of PD events in high voltage power apparatus. The sensor has been fabricated to detect corona and surface discharge events in the laboratory. The frequency response of the proposed sensor has been initially examined using simulation and were further verified using experiment. Using the proposed sensor, PD measurement has been conducted on two standard sources i.e. corona and surface discharge, respectively. Investigations revealed that the proposed sensor can detect PD events accurately operating within the frequency band of 250 kHz to 10 MHz, ideally suited for PD measurement in any high voltage (HV) apparatus. The performance of the developed sensor is found to be better than the commercially available HFCT in terms of PD detection sensitivity. The proposed sensor can be practically applied for online condition monitoring of high voltage equipment.

Estimation of Inertial Transfer Function Coefficients and Algorithm Development for Forecasting Inertia in Indian National Electricity Grid

Debanjan Mukherjee (Indian Institute of Technology Guwahati); Nikhil Kumar Mishra (Indian Institute of Technology Guwahati); Karuna Kalita (Indian Institute of Technology Guwahati); Subhash Kumar (Grid-India); Amaresh Mallick (Grid-India); Samar Chandra De (Grid-India)*

Abstract: India plans to supplement 50% of the electricity demand through renewables by 2030. This manuscript primarily aims to estimate inertial transfer functions in the considered renewable energy penetration scenario of 30-35% by analyzing the frequency response behavior of the generation-loss grid disturbances of above 600 MW in the Indian National Electricity Grid from December 2020 to June 2023 from Phasor Measurement Unit-frequency data at 1-second intervals. The estimation considers the proportional lag-compensator control function to imitate the primary and secondary grid frequency control response. The novelty of this study lies in the methodology for evaluating the transfer functions capable of predicting future grid disturbances with high accuracy. The other novelty of the manuscript is the development of an algorithm to calculate real-time universal grid transfer function for forecasting generation-loss grid disturbances. The algorithm can be developed into an artificially intelligent tool that can be exercised by grid operators in India and worldwide to estimate kinetic energy losses occurring and active power inertial reserve capacities required to combat grid disturbances. This will uncover opportunities to design, develop, and schedule grid-sale inertial energy storage systems for reliable and flexible operations in the future.

Review of Condition-based Monitoring Techniques for Electrical and Industrial Assets to Promote Digitalization Strategies for Utilities

*Bibhudatta Patnaik (GE Vernova); Nikhil Kumar Sharma (GE Vernova); Priyabrata Shaw (GE Vernova)**

Abstract: Asset reliability and availability are two of the most important criteria in any industry. In the modern power systems, the requirement for continuous and quality power is more stringent as every industry depends on the same. In this regard, advanced maintenance techniques like Condition Based Maintenance (CBM) and Prognostics Health Management (PHM) have become increasingly popular. The paper explores CBM and PHM techniques, as real-time monitoring solutions that assist in condition assessment & optimization, remaining life prediction, proactive maintenance and operational planning. The paper segregates electrical utilities based on generation, transmission & distribution segments and

identifies the important assets in each segment, further diving into the failure modes, identifying parameters for monitoring and exploring techniques for CBM and PHM. The paper also highlights the increase in demand for CBM solutions with projections till 2029.

Enhancing the frequency regulation in multi-area deregulated power system integrated with EV using modified LADRC controller

Pranav Singh (NIT Patna); Ravi Shankar (NIT Patna); S.N Singh (IIT Kanpur)*

Abstract: In order to improve Power System Frequency Regulation (FR), this article suggests a multi-area deregulated power structure based on electric vehicles (EVs). In each control region, the power system under study integrates three distinct energy sources (biogas, nuclear and thermal) with a number of verified real-time nonlinearities, such as boiler dynamics, Governor Dead Band (GDB) and Generation Rate Constraint (GRC). A novel cascade combination of Linear Active Disturbance Rejection Controller (LADRC) with (1+Tilt Derivative) controller is proposed and successfully implemented for frequency regulation. A few existing controllers have been compared with a newly developed modified LADRC-(1+TDN) cascade controller. A new modified Chaotic Quasi-Opposition based crayfish optimization algorithm (CQO-COA) technique has been employed to maximize the gain of the proposed controller. The superiority of the CQO-COA is shown by comparing it with many popular meta-heuristic optimizations. ITSE is taken as a performance index. This analysis has been used to confirm the suggested controller's resilience and adaptability under poolco-based transactions. The throughout analysis offers convincing evidence of the effectiveness and efficacy of the proposed controller and optimization.

Decentralized Load Frequency Control of a Multi-Area Cyber-Physical Power System

*Srikanth Bondalapati (National Institute of Technology, Silchar); Rajeeb Dey (National Institute of Technology, Silchar)**

Abstract: The penetration of renewable energy sources (RES) is a requirement of the present-day deregulated power market. However, deregulation poses certain modeling & control challenges, (1) RES penetration into the conventional Load Frequency Control (LFC) of the power system makes the dynamics complex due to the different dynamic characterization of the RES, (2) inclusion of the open communication infrastructure (networked communication) thereby impose certain constraints like latency (delay), randomness of the data, data security, communication protocols, loss of data, which affects the dynamics greatly. To interlink these aspects, namely RES integration and network communication constraints, the power system is being remodeled as a Cyber-Physical Power Systems (CPPS). To address these issues of modern power system requirements, a decentralized PID control using Linear Quadratic Differential Game (LQDG) theory is designed to handle the stabilization & disturbance rejection for a CPPS model. The performance of the designed controller is tested on a 39-bus system, which includes an open communication network (ethernet) to communicate control signals between sensor & actuator nodes with most of the constraints mentioned above.

A Novel Reaching Law-based Double Integral Sliding Mode Control for Automatic Voltage Regulator

Pritom Aich (Daffodil International University); Soumik Dev (Khulna University of Engineering & Technology); Anis Ahmed (Khulna University of Engineering & Technology); Ovishak Roy (Khulna University of Engineering & Technology); Rakibuzzaman Shah (Federation University Australia); Amirtesh Kumar (National Institute of Technology Silchar)*

Abstract: The Automatic Voltage Regulator (AVR) plays a key role in maintaining system stability by controlling generator excitation. This study proposes a novel-reaching law and implements a double integral sliding mode controller (DISMC) to enhance AVR performance. A state-space model of the

AVR system is developed and analyzed for controller design. Key performance metrics, including overshoot, settling time, and rise time, were evaluated and compared with traditional sliding mode control (SMC) and terminal sliding mode control (TSMC). Simulation results indicated that DISMC outperformed both SMC and TSMC, exhibiting superior transient response, faster error elimination, and a smoother control signal with low chattering. All designs, analyses and validations are conducted using MATLAB/MATLAB Simulink software.

Target-loop based Cascaded Fractional-order Control for Non-integer Processes: Application on a PEM Fuel Cell

Rammurti Meena (NIT Silchar); Dipjyoti Das (NIT Silchar); Sudipta Chakraborty (NIT Silchar); Vipin Chandra Pal (NIT Silchar)*

Abstract: This paper aims to achieve two objectives. Firstly, it addresses the tracking challenge associated with ramp-type set-points and disturbances, where conventional methods typically result in steady-state errors. Secondly, it simplifies the design of fractional-order controllers, which often involve intricate computations in existing approaches. The proposed target loop-based controller design effectively manages both step and ramp-type set-points as well as disturbance inputs. The key advantage of the proposed design lies in its ability to be analytically tuned based on specified maximum sensitivity and phase margin criteria. Clear relationships for the new fractional-order ramp controller parameters are derived, simplifying the tuning process. Numerical analyses demonstrate enhanced servo and regulatory performance compared to recently published methods. The proposed controller ensures system stability and achieves zero steady-state error when responding to a rising ramp input.

Design of Event-Based Sliding Mode Controller under Denial of Service Attack

Rahul Verma (NIT Rourkela); Krishanu Nath (NIT Jalandhar); Manas Bera (NIT Rourkela)*

Abstract: This paper addresses the problem of robust stabilization of linear-time invariant (LTI) systems subjected to periodic denial-of-service (DoS) attacks in the framework of cyber-physical systems (CPSs). A resource-aware sliding-mode control (SMC) strategy using an event-triggered mechanism (ETM) is introduced to deal with external disturbances and DoS. The ETM reduces the network communication demands and computations, while the SMC-based control law is designed to ensure robust system performance under the impact of external disturbances and DoS attacks. Adequate conditions on the ratio of attack durations are derived that guarantee the existence of a practical sliding motion despite the presence of these DoS attacks. Additionally, it is shown that the execution time intervals of the ETM have a positive lower bound, eliminating the occurrence of Zeno behaviours. A satellite control system example is used to illustrate the efficacy of the suggested methodology.

Smart Urban Waste Management System Powered by AI and IoT for Efficient Collection, Segregation, and Disposal

*Chandan Kumar (NIT Mizoram)**

Abstract: The Smart Urban Waste Management System offers a modern solution to the difficulty of urban waste management by using IoT, AI, and Blockchain technologies to make the process more efficient, transparent, and sustainable. The system uses IoT-enabled smart bins with sensors to monitor waste levels and give real-time data to waste management platforms. With AI and computer vision, the system can divine waste generation patterns to plan better, optimize waste collection routes, and automate waste segregation for better order. Blockchain technology is critical in ensuring secure and transparent waste collection, segregation, and disposal tracking, fostering obedience in urban waste management systems. In addition, Internet of Things (IoT) communication agreements such as LoRaWAN (Long Range Wide Area Network) and NB-IoT (Narrowband IoT) are increasingly adopted due to their low cost, high scalability, and minimal power consumption, making them acceptable for

large urban areas. These orders allow for real-time monitoring and management of waste-related data across the city, serving authorities and stakeholders to make literate decisions. This paper surveys how blockchain and IoT technologies can seamlessly integrate to generate a circular, data-driven urban waste management ecosystem. This system aims to proceed with the principles of the circular economy by promoting the reuse of resources and energy recovery from waste materials. By leveraging blockchain's ability to give tamper-proof records and IoT's capability for continuous data collection, the proposed ecosystem can increase efficiency, reduce operational costs, and minimize environmental impacts. moreover, integrating these technologies supports better stakeholder collaboration, improved compliance with waste management regulations, and the development of smarter, more sustainable cities.

Enhancing the frequency regulation in hybrid deregulated AGC incorporating modified 2DOF cascaded controller.

Prabhat Vidyarthi (NIT Patna); Ashiwani Kumar (NIT Patna); Ravi Shankar (NIT Patna)*

Abstract: This research aims to investigate how the intermittent character of Renewable Energy Sources (RESs) is shown in Automatic Generation Control (AGC) in a hybrid restructured power system. In addition to two different energy sources thermal and bio plant in each control area, the power system under investigation includes verified real-time nonlinearities, such as boiler dynamics, Governor Dead Band (GDB), and Generation Rate Constraint (GRC). For both scheduled and unscheduled electricity under different contracts, such as poolco, bilateral transaction and contract violation transactions. Three controllers PID, TIDN, and 2DOF(PI)-TDN (proposed) are incorporated across a variety of power transform model. Furthermore, RESs like wind and solar power plants are proposed as case studies. The effectiveness of proposed controller is compared with existing controller. To optimize the various gain parameters of the proposed controller, a modified version of the Quasi-Opposition based Crayfish Optimization Algorithm (QO-COA) technique has been proposed. Different results and case study analysis was conducted under poolco-based transactions to verify the suggested controller's resilience and adaptability. IEEE-39 bus system is utilized to find the robustness of proposed controller.

Robust fault tolerant control based on adaptive backstepping terminal sliding mode

Shrestha Ghosh (National Institute Of Technology, Silchar); Nabanita Adhikary (National Institute Of Technology, Silchar)*

Abstract: This paper proposes a modified control law for Fault tolerant control (FTC) based on adaptive backstepping terminal sliding mode control (ABTSMC) for trajectory tracking control of robotic manipulators. The design integrates the benefits of terminal slide mode control (TSMC) with backstepping control against the proposed time-dependent fault that represents the actuator fault. The model is also tested for parametric deviations and external noise.

Advance Technology based Circuit Breaker acknowledge through PZEM-004T Module

Yogesh Kumar (Axis Institute Of Technology And Management, Kanpur ,UP); Anand Raj (Axis Institute Of Technology And Management, Kanpur ,UP); Anurag Raj (Axis Institute Of Technology And Management, Kanpur ,UP); Kushagra Gupta (Axis Institute Of Technology And Management, Kanpur ,UP); Madhuri Singh (Axis Institute Of Technology And Management, Kanpur ,UP); Santosh Kumar (Axis Institute Of Technology And Management, Kanpur ,UP)*

Abstract: This research paper introduces an innovative circuit breaker system that integrates advanced technologies to enhance electrical safety and automation. The system utilizes the PZEM-004T energy monitoring module and features dual security measures, including a keypad and fingerprint recognition, to ensure secure access control while providing robust protection against electrical faults. Equipped

with a fire sensor, buzzer, and LED indicators, the circuit breaker facilitates immediate alerts in hazardous conditions, thereby improving user safety. The incorporation of IoT connectivity through the ESP32 microcontroller allows for real-time monitoring and control from remote locations. A 20x4 LCD display provides users with essential information regarding energy consumption, system status, and alerts. To further enhance functionality, a Telegram bot is implemented, enabling users to receive notifications and control the circuit breaker through a user-friendly mobile interface. This feature not only boosts user engagement but also allows for timely responses to potential electrical issues, minimizing risks associated with electrical failures. The research methodology encompasses the design, implementation, and testing of the circuit breaker system, focusing on performance evaluation in various scenarios. Results indicate that the dual security measures significantly enhance access control, while the integration of IoT capabilities offers a seamless monitoring experience. The system demonstrates high reliability and responsiveness, making it suitable for both residential and industrial applications.

Operation Risk Based Optimal µPMU Placement In Distribution Network Considering Radial Buses

*Manas Mukherjee (Institute of Engineering and Management Kolkata, IEM UEM Group)**

Abstract: This paper proposes an operation risk based optimal Micro-PMU (µPMU) placement in distribution networks excluding µPMUs at radial buses. Radial buses have single connectivity. Therefore, µPMU at radial bus decreases measurement redundancy, popularly known as system observability redundancy index (SORI). A reduced SORI has adverse effect during contingency such as µPMU outage condition. On another side, operation risk of a node is pivotal for determining µPMU location. Existing literature shows that µPMUs must be placed at radial buses having lower operation risk to avoid loss of observability (LoB). This consideration is certainly true for unreliable node outage consideration. However, it is not true for µPMU outage consideration. During µPMU outage condition, each bus except radial buses should be doubly observable due to techno economic reason. Therefore, excluding radial buses from direct metering enhances SORI as well as meter procurement cost. The proposed algorithm simulated on IEEE 33 bus system explicitly shows its efficacy in terms of Total System Operation Risk, LoB and SORI.

Extended State Observer-based Controller for Cuk Converter

Rakesh Rai (IIT Delhi); Mummadi Veerachary (IIT Delhi)*

Abstract: A robust extended state observer-based Cuk converter controller design and analysis is discussed in this paper. This controller design takes the parameter variation into account and hence yields better dynamic response. It estimates the unmodelled disturbance using an extended state and compensates it internally to the control law. For comparison purposes, the PI (proportional-integral) and PID control are also designed and analyzed. It is seen that by writing PI, PID control as a unified form of disturbance observer-based control, integral action works as an estimation of disturbance. After that, a theoretical analysis is carried out to assess fairly and show the performance improvement of the ESO-based controller. The finding indicates that without using extra sensors, the proposed controller dynamic responses are superior, and it is robust against its circuit parameter variations. Simulation results also suggest the improvement of the discussed control law.

An Efficient Two-Point DFT Interpolation Approach for M-Class Synchrophasor Measurement

*Mukesh Kumar (National Institute Of Technology Patna)**

Abstract: Synchrophasor measurement, an evolving technology, plays a crucial role in monitoring and controlling smart grid applications. It enables real-time supervision and control of the power system effectively under steady and dynamic states. The methodology of phasor estimation has a crucial role

in ensuring the reliability of the synchrophasor measurement. This work attempts to achieve the performance requirement of the synchrophasor measurement using an efficient two-point DFT interpolation approach with a lower sampling rate. The method estimates the frequency deviation factor using the correlation of the DFT magnitude response, thereby estimating the actual frequency. In addition, an efficient interpolation approach using two peak points of the magnitude response obtained from the DFT is interpolated to estimate the magnitude and phase angle of the given signal. Further, the rate of change of frequency (ROCOF) is also estimated using the estimated frequency. The performance of the proposed approach is evaluated according to the IEC/IEEE 60255-118-1:2018 standard and also compared with the reference model. The performance evalaution reveals that the proposed method fulfills the performance requirements with an efficient algorithm.

Comparative Analysis of Control methods for Enhancing the Performance of the Bidirectional DC-DC Buck-Boost Converter

Riju Nandi (NIT Rourkela); Arnab Ghosh (NIT Rourkela); Riju Nandi (NIT Rourkela)*

Abstract: In this paper, eight different control methods on DC-DC Bidirectional Buck-Boost Converter (BDC), are compared with together. Several control methods like PID, IMC, Lag-lead, Lead-lead, Lead-lag, 1-DOF PID, 2-DOF PID, 3-DOF PID are used for controlling the BDC. The results show the capability of control methods in the improvement of the above-mentioned converters functioning.

Open-Circuit Fault Diagnosis in Multilevel Inverters Implementing PCA-WE-SVM Technique

Kumari Sarita (Government Engineering College Aurangabad, Bihar); Sachin Kumar (GBPIET Pauri Garhwal Uttarakhand); RK Saket (IIT (BHU), Varanasi)*

Abstract: The occurrence of Open-circuit (OC) faults is frequent in power electronics inverter switches. In multilevel inverters (MLI), it is difficult to diagnose the OC fault in switches. Simultaneously, the localization of the exact faulty switch is not a straightforward task. The electrical system performance depends on the converters' proper functioning, inverters, and system components. An OC fault in a single switch results in the deterioration of the converter output. The OC faults in the multi switches may lead to damage to the system components. Therefore, switches used in such a system must have an appropriate fault-tolerant capacity. It is the capacity observed using redundant switches in operation under fault conditions. For this, the detection time of OC fault must be as minimum as possible. Hence, this work focuses on the detection and localization of OC faults in Insulated-Gate Bipolar Transistors (IGBTs) of three-phase, three-level inverters. A Principal Component Analysis (PCA)-based algorithm is implemented in this work to detect OC faults in IGBTs. Also, a Support Vector Machine (SVM)-based algorithm is implemented to localize a faulty switch. The feature used for fault classification is the Wavelet Entropy (WE) of inverter three-phase currents. The work shows that the fault detection and localization time is reduced, and accuracy is improved using the proposed technique. The output results are compared to the previously available methods, which show the proposed techniques' improvement and show clear evaluation with the theoretical prediction developed.

MPC-Based Control of Dual Active Bridge Converter for DC-Link Voltage Stabilization in PV-Battery DC Microgrids

Jayadev Meher (NIT Rourkela); Krishna Roy (NIT Rourkela); Arnab Ghosh (NIT Rourkela)*

Abstract: The integration of photovoltaic (PV) and battery energy storage systems in DC microgrids is the challenge of having a stable DC-link voltage based on power generation variability and dynamic load changes. Mitigating that, this paper presents a Model Predictive Control (MPC) technique to stabilize the DC-link voltage via a Dual Active Bridge (DAB) converter. In addition, a Single-Ended Primary Inductor Converter (SEPIC) is utilized for maximum power point tracking (MPPT) of the solar PV system with improved voltage conversion flexibility compared to conventional boost converters.

The SEPIC converter effectively taps the maximum power deliverable from the PV system, and the DAB converter effectively handles bidirectional power flow between the PV system, battery, and DC bus, thus ensuring voltage stability. The MPC algorithm predicts system dynamics in real time and selects optimal control policies considering system constraints and minimizing voltage deviations. The validation of effectiveness is done through Simulation results of the proposed MPC-based control strategy in maintaining stable DC-link voltage and in PV-battery-based DC microgrids.

Real-Time Forest Fire Detection Using ESP32 Microcontroller with Cloud-Integrated Monitoring System

Ajay Kumar (Dept. of CSE, Manipal University Jaipur, Rajasthan 303007, India); Lav Upadhyay (Dept. of CSE, Manipal University Jaipur, Rajasthan 303007, India); Pranshu Pranjal (Manipal University Jaipur); Priyanka Paygude (Department of Information Technology Bharati Vidyapeeth University (Deemed to be University) Pune, India)*

Abstract: This research article offers an innovative approach for detecting forest fires in real time by integrating environmental sensors with ESP32 microcontroller nodes. These nodes continuously monitor critical parameters such as temperature, humidity, and smoke levels, serving as an initial defense against wildfires. The system utilizes a master-slave architecture to efficiently collect and transmit data to a cloud platform. This enables remote access for authorized personnel to monitor sensor readings in real-time and configure alerts from anywhere with internet connectivity. By incorporating machine learning algorithms to analyze historical data, the system can identify fire risk patterns swiftly and accurately. This capability facilitates proactive measures to mitigate potential outbreaks, thereby minimizing ecological damage and ensuring firefighter safety. The system's scalability allows for deployment over extensive forest areas, establishing a comprehensive and intelligent network for early fire detection and response.

Automatic Control & Weight Monitoring Of A Vacuum Based Grain Collecting Machine.

Siva Ram Ganesh Motepalli (Shri Vishnu Engineering College for Women); Harika Devi Kosuri (Shri Vishnu Engineering College for Women); Sri Ramya Adabala (Shri Vishnu Engineering College for Women); Purna Sri M (Shri Vishnu Engineering College for Women); Veda Sushma Sri T (Shri Vishnu Engineering College for Women); Divya Sri P (Shri Vishnu Engineering College for Women)*

Abstract: This paper presents the design and implementation of a vacuum-based grain collecting machine's automatic control and weight monitoring system. The system allows users to set specific weight limits, automatically stopping collection upon reaching the threshold to prevent overloading and ensure efficiency. Integrating automation enhances precision and optimizes grain harvesting, contributing to smart farming advancements. This scalable solution modernizes agricultural practices, improving productivity for farmers.

A Direct Method to Improve the Load Margin of Power Systems

*Murilo E. C. Bento (Federal University of Rio de Janeiro)**

Abstract: The complexity of power system operations increasingly demands dynamic safety assessment tools and effective control measures to ensure system stability. Load Margin is an important index to assess system safety, but it usually considers only voltage stability requirements. Load Margin can also be affected by the presence of low-frequency oscillation modes with low damping ratios that are commonly studied in small-signal rotor angular stability. This paper proposes the use of the direct method to improve the Load Margin of power systems through a control measure. This direct method considers mutual requirements of voltage stability and small-signal stability. Detailed case studies are discussed with a preventive control action.

A Five-Stage Algorithm For Estimating Electromechanical Modes of Power Systems

*Murilo E. C. Bento (Federal University of Rio de Janeiro)**

Abstract: Power system monitoring is essential to ensure the quality and continuity of the electrical power supply. In stability studies, the presence of oscillation modes with low damping ratios can compromise the stable operation of the system and require control measures when necessary. This paper proposes a five-stage algorithm for the identification of electromechanical modes associated with low damping ratios of the system. Case studies are detailed and discussed and the results achieved highlight the benefits of the five-stage algorithm.

Fixed-Time Super Twisting Sliding Mode Average Consensus of Perturbed Multi-agent Systems

TARA SWARAJ (National Institute of Technology Silchar); Krishanu Nath (Dr B R Ambedkar National Institute of Technology Jalandhar); Manas Kumar Bera (National Institute of Technology Rourkela); Rajiv Kumar Mishra (National Institute of Technology Rourkela); Sudipta Chakraborty (National Institute of Technology Silchar)*

Abstract: This manuscript discusses fixed-time average consensus control for second-order multi-agent systems in the presence of disturbance. Communication among agents is considered undirected. The proposed control scheme uses a new fixed-time super-twisting sliding-mode consensus protocol to address the matched disturbance in the agents. The sliding manifold for the super-twisting control is designed based on the existing fixed-time protocol, which guarantees that the sliding phase is fixed-time. Using the bi-limit homogeneity method and the Lyapunov stability theory, the average consensus can be obtained over a fixed time. Finally, simulations illustrate the effectiveness of the proposed controllers.

Development and Execution of a Model Predictive Control Technique for Hybrid Microgrid

Pranati Purohit (NIT Rourkela); Arnab Ghosh (NIT Rourkela); Pravat Kumar Ray (NIT Rourkela)*

Abstract: An effective two-way dc-dc buck-boost converter control approach in a hybrid photovoltaic (PV)- wind system with battery as the energy storage is described in this study for managing power flow. Meeting load demand, controlling power flow from various sources, and charging the battery on demand are all goals of the proposed system. To control the charging and discharging of batteries as well as to track power from wind and solar photovoltaic sources, a buck-boost converter is utilized. The two-way dc-dc converter is controlled using the model predictive control algorithm to stabilize the dc-bus voltage and to ease the output of hybrid energy sources, which is unpredictable. The simulation results demonstrate the capability of the system operation under varying photovoltaic irradiance and wind speed. The simulation outcomes derived from MATLAB/Simulink validate the controller's performance.

Experimental Comparative Analysis between IMC and Smith-Predictor on a Two-tank Level Control

Dipjyoti Das (NIT Silchar); Sudipta Chakraborty (NIT Silchar); G Lloyds Raja (NIT Patna)*

Abstract: This study presents a comprehensive comparative analysis between two prominent control methods, namely, Internal Model Control (IMC) and Smith Predictor (SP), specifically tailored for managing large time-delayed integrating processes. The investigation delves into the theoretical underpinnings and practical implications of these approaches within the realm of process control. Through rigorous experimentation and validation, the study assesses their efficacy, robustness, and performance in real-world scenarios, aiming to elucidate their strengths, limitations, and suitability for addressing substantial time delays in industrial processes. The findings derived from this comparative study offer valuable insights and recommendations, empowering practitioners and researchers to make informed decisions regarding the control strategy for large time-delayed systems.

Data-Driven Diagnostic Analysis of an Oil Leakage Incident in a Utility-Scale Distribution Transformer

*Dr. Abdul Haleem Medattil Ibrahim (R&D Centre-Dubai Electricity and Water Authority(DEWA))**

Abstract: Oil leakage in power distribution transformers is a critical reliability concern, often leading to insulation degradation, overheating, and potential failure if left unaddressed. Identifying the underlying causes of oil leakage and its impact on transformer performance is essential for maintaining grid stability and operational safety. This paper presents a data-driven diagnostic analysis of an oil leakage event. This event happened from a four winding distribution transformer connecting a utility scale Battery Energy Storage System (BESS) part of a PV generation plant to the grid. The analysis employed a systematic approach deploying the historic data collected from a transformer edge processing device. The analysis included high-sampling-rate voltage and current data from both the low-voltage (LV) and high-voltage (HV) sides of the transformer. Additionally, electrical parameters such as the severity factor and excitation current trends were calculated. A root cause analysis was performed to identify anomalies influencing transformer performance. The study examines the correlation between the transformer operating conditions as measured from the monitoring device and the oil leakage occurrence, offering valuable insights into the implications of the oil leakage on the transformer reliability. Furthermore, the diagnostic analysis findings were validated using post-event maintenance reports, reinforcing the accuracy and effectiveness of the proposed methodology. The findings underscore the importance of data-driven diagnostics in boosting predictive maintenance and enhancing the reliability of distribution transformers.

An Observer Based Phase-Locked Loop with DC-offset Rejection Capability for Single-Phase Grid-Tied Converter

Faridul Hassan (NIT Silchar); Benjamin Stickan (Fraunhofer Institute for Solar Energy Systems, Germany); Amritesh Kumar (NIT Silchar); Avadh Pati (NIT Silchar)*

Abstract: The presence of a DC offset in the measured grid voltage poses a challenge to the proper synchronization and control of single-phase grid-connected converters. It leads to oscillations and offset errors in the estimated grid voltage parameters. Fast and accurate extraction of synchronizing signals is most important for the high performance of grid-connected systems and for monitoring the grid conditions. To enhance the performance in the presence of a DC-offset signal, this paper presents a novel approach for quadrature signal generation (QSG) based on an observer (OB-QSG). Utilizing the OB-QSG, a phase-locked loop (PLL) is realized. The results are compared with an advanced SOGI-based PLL under various grid disturbances, along with the DC offset. The mathematical modeling of the OBQSG is also presented.

Robust Virtual Inertia Control of a Microgrid Using Quantitative Feedback Theory

*Syed Nikhat Asfia (National Institute of Technology Warangal); JeyaSenthil R (National Institute of Technology Warangal); Tarakanath Kobaku (IIT Patna); Vinod Kumar Bussa (IIT Patna)**

Abstract: This work presents a resilient robust virtual inertia control for highly renewable energy penetrated microgrid is developed using Quantitative Feedback Theory (QFT) approach. The growing installation of renewable energy sources reduces system inertia, which in turn causes frequency instability. The QFT-based virtual inertia robust controller accounts microgrid system uncertainties and improves performance of frequency regulation for sudden variations in inertia and local power demand. The efficacy of the proposed QFT based virtual interatia control strategy is validated in Matlab/Simulink simulations. A deatiled comparison with some of the popular control techniques such as SISO tool tuned PI/PID, internal model control (IMC), and pole placement controller is provided. The simulation results show that QFT provides negligible frequency deviation for disturbances, ensuring robust disturbance rejection and robust stability.

SPECIAL SESSION 1:

Advances in Control and Operation of Inverter-Dominated Power Distribution System

Hybrid Metaheuristic Approach for Optimal LCL-Filter Design in Grid-Connected Inverters Using CSA-PSO with Adaptive Parameter Tuning

Mrinal Rajak (National Institute of Technology Arunachal Pradesh); Devanand Kumar (National Institute of Technology Arunachal Pradesh); Rajen Pudur (National Institute of Technology Arunachal Pradesh)*

Abstract: This paper presents a hybrid Circle Search Algorithm with Particle Swarm Optimization (CSA-PSO) for optimizing LCL filter design in grid-connected inverters. The proposed method achieves significant performance enhancements, including a 32.7% reduction in Total Harmonic Distortion (THD) from 2.45% to 1.65%, and substantial reductions in component sizes: L1 (3.6mH to 2.82 mH, −22%), L2 (1.2mH to 0.81 mH, −32%), and C (4.7 μF to 2.50 μF, −47%). Dynamic performance analysis demonstrates 48% lower overshoot (6.4% vs. 12.3%) and 33% faster settling time (12 ms vs. 18 ms). During 90% grid voltage sags, CSA-PSO achieves 38% lower current oscillation compared to traditional methods. Harmonic spectrum analysis reveals superior attenuation, with a 25% improvement in the fundamental frequency component and a 45% reduction in high frequency harmonics. The steady-state response shows improved current tracking, reducing ripple from 0.85A to 0.42 A, while three-dimensional spectral analysis confirms enhanced harmonic suppression across all frequencies, particularly a 40% average reduction in the critical 2nd–13th harmonic range. The optimized design complies with IEEE 519-2014 and IEC 61000-3-2 standards while reducing component costs by 35%. Simulated fault ride-through tests show a 42% faster recovery time after fault clearance, maintaining stability margins above 45◦ and 6 dB.

Optimizing Matrix Converter Performance Using Hybrid Particle Swarm Optimization and Gradient Descent Techniques

Unmesh Naik (National Institute of Technology Arunachal Pradesh); Mrinal Kanti Rajak (National Institute of Technology Arunachal Pradesh); Mohan Vithalrao Aware National Institute of Technology Arunachal Pradesh H); Rajen Pudur (National Institute of Technology Arunachal Pradesh)*

Abstract: This paper presents a comprehensive comparative analysis of three optimization algorithms—Particle Swarm Optimization (PSO), Modified PSO (MPSO), and Hybrid PSO with Gradient Descent (HPSOGD)—for matrix converter optimization, validated through hardware-in-loop (HIL) implementation. The experimental results demonstrate HPSOGD's superior performance, achieving a Total Harmonic Distortion (THD) of 6.1%, marking a substantial 30% improvement over conventional PSO's 8.7% THD and outperforming MPSO's 6.7% THD. The convergence analysis across multiple operating frequencies (5Hz, 50Hz, and 100Hz) shows HPSOGD consistently achieving optimal fitness values of 6.0, 7.0, and 5.0 respectively, compared to PSO's higher values of 8.0, 9.0, and 7.0. HIL implementation validates these results through real-time waveform analysis, demonstrating stable voltage regulation and effective harmonic suppression, with higher-order harmonics maintained below 15% of the fundamental magnitude. MPSO, utilizing adaptive parameters and enhanced neighborhood topology, achieves a 23% THD improvement over conventional PSO, positioning it as an intermediate solution. The oscilloscope measurements confirm superior switching pattern quality in HPSOGD, with 50% duty cycle optimization and minimal switching noise. Convergence rates average 2.33 units per iteration across all algorithms, with HPSOGD demonstrating enhanced stability in reaching optimal solutions.

Double Boosted voltage 5 Level Inverter Topology for Renewable Energy Applications

Vinayak Kumar (National Institute Of Tecnology Patna); Ruchi Agarwal (National Institute of Technology Patna); Ranjan Kumar Behera (IIT PATNA); Pravindra Kumar (NIT Patna)*

Abstract: The article presents 5-level inverter topology, designed with the lowest component counts. It is suited for renewable energy application due to capable of double boosting feature. The switching

capacitor approach is utilized in the proposed topology, therefore single DC source is needed for generation of 5-level. Due to diminished voltage and current stress, lower rated switches are employed to form the proposed inverters. The level shifted phase-disposition carrier pulse width modulation (LSPDC-PWM) technique is used for the switching purpose, therefore the capacitor is self balanced without extra need of control, therefore lesser the computational burden as compared to the other published topologies. The detailed comparative analysis is shown in the tabular form for highlighting the benefits in terms of number of component count, total standing voltage, maximum standing voltage and voltage gain of the proposed topology. A theoretical study is provided for assessing power loss and selecting passive components. The proposed inverter is simulated using MATLAB/Simulink software to validate the theoretical study. The HIL Opal RT-5700 is employed for real-time validation purposes.

Battery Management System for Smart Wi-Fi Router Adapter for Rural Applications

Ajit Singh (NIT Jamshedpur); Tarak Nath Mahato (NIT Jamshedpur); Kamal Kant (NIT Jamshedpur); Omhari Gupta (NIT Jamshedpur)*

Abstract: In the modern era, internet access is essential for every human being for business, communication, entertainment, travelling, education, research and development, digital transactions, etc. This paper focuses on the continuous electricity supply requirement of Wi-Fi routers for internet access. The power backup is necessary for remote, rural, and urban internet access. Due to the failure of power, important transactions will fail. In this paper, a smart adapter for Wi-Fi routers with storage capacity has been discussed. A power backup system enhances the resilience and seamless integration of Wi-Fi Routers. A power backup system requires simple and less infrastructure for this setup. Li-Ion-based chargeable storage system receives the power from the supply when available. When the supply is unavailable, the Wi-Fi router gets the power from a Li-Ion-based battery. In case of a power outage, the Li-Ion battery may supply the Wi-Fi router with power for up to 5 hours. Battery management systems regulate and monitor the charging and discharging process, state of charge (SOC), residual operating time, capacity and power consumption for batteries. A bidirectional converter (BDC) interfaces the Li-Ion batteries between the supply and load. BDCs are used to supply flawless power in both directions. Power adapters receive power from the supply and step down at a suitable voltage (12V) for the Wi-Fi router. The power adapter handles power factor enhancement, protection issues, and temperature control management to improve the efficiency and reliability of the system.

Impedance Based Stability Analysis of DC Microgrid

Khalid Khan (IIT (ISM), Dhanbad); Kartick Jana (IIT (ISM), Dhanbad)*

Abstract: As the number of power electronic converters in a microgrid increases, the stability of the system is compromised due to the undesirable small signal impedance interaction between different types of converters hence present. While the parameters of the individual converters are determined by performing stability analysis of various small signal transfer functions, it is not guaranteed to achieve sufficient stability margin on the microgrid level due to the impedance dynamics introduced by the closed-loop control system of these converters. To this end, the proposed work has developed a closed loop input and output impedance transfer function of a DC microgrid by splitting the microgrid into two subsystems namely the source and load subsystems. The source and converter regulate the DC microgrid voltage from the source subsystem whereas the remaining components are included in the load subsystem. The closed-loop transfer functions of the subsystems are then analyzed with the Nyquist criterion to check the stability of the DC microgrid. The studied DC microgrid system has four sources which are PV, PMSG – Wind turbine, battery energy storage system (BESS), and three-phase utility grid. Moreover, DC and AC loads are also considered.

Analyzing the Performance of Linear and Nonlinear Multi-Period Optimal Power Flow Models for Active Distribution Networks

Aryan Ritwajeet Jha (Washington State University); Subho Paul (Indian Institute of Technology (BHU) Varanasi); Anamika Dubey (Washington State University)*

Abstract: With the rapid integration of grid edge devices (GEDs) such as batteries and solar photovoltaics, multi-period optimal power flow (MPOPF) frameworks have become essential for managing modern electricity distribution networks (EDNs). Traditional MPOPF formulations based on nonlinear branch flow models yield non-convex programming (NCP) problems that suffer from slow convergence and high computational demands. Linear programming (LP)-based approaches, while computationally efficient, introduce an optimality gap. Despite their promise, the impact of EDN size and GED penetration on this gap remains underexplored. In this paper, we develop and compare MPOPF models using both NCP (via a nonlinear branch flow model) and LP (using the LinDistFlow approximation) formulations. Our evaluation on a small (10-bus) and a medium (IEEE-123-bus) system under varying GED deployments—validated through OpenDSS simulations—reveals that although the LP-based methods incur an increasing optimality gap with larger system sizes and higher battery penetration, they achieve near-optimal performance in terms of the primary cost objective. However, significant discrepancies in other decision variables, such as reactive power dispatch and substation power predictions, warrant greater caution when employing the LinDistFlow model in practice.

An eSO-CCF Based Fundamental Component Extraction for Three/Single-Phase System

Faridul Hassan (Nit Silchar); Amritesh Kumar (NIT Silchar); Avadh Pati (NIT Silchar)*

Abstract: The Generalized Integrator (GI)-based complex coefficient filter (CCF) is a promising solution for extracting fundamental component of the signals, quadrature signal and grid voltage parameters under distorted grid conditions. It has gained considerable attention in three-phase systems due to its ability to handle complex input signals and its frequency-selective harmonic extraction capabilities. However, under weak-grid conditions with high distortion, harmonics, sub-harmonics, and dc offsets, its performance deteriorates, failing to extract accurate fundamental component of the signals and therefore synchronization signals get affected. This letter proposes an enhanced second-order CCF (eSO-CCF) for both three-phase (3ϕ) and single-phase (1ϕ) systems, capable of extracting fundamental components more accurately and rejecting dc offsets robustly under weak-grid conditions. Performance of the proposed eSO-CCF is validated through MATLAB/SIMULINK simulations and experimental results on an FPGA-based controller, compared with CCF, SO-CCF, and fourth-order-GI/second-order-SOGI.

SPECIAL SESSION 2:

Protection Solutions for Inverter Based Resource Dominated Smart Power System (PS-IBR-SPS)

A Novel Backup Protection Function to Realize Dependable Numerical Protection

*Thiyam Stalin Singh (National Institute of Technology Silchar (An Institute of National Importance)); Asha Rani M A (National Institute of Technology Silchar (An Institute of National Importance)); Mallikarjuna Balimidi (National Institute of Technology Silchar)**

Abstract: This paper proposes a backup protection function to realize dependable numerical protection. The proposed function detects and classifies the disturbance using the current index and power factor, and further is classified as a fault or stressed condition using current index. These parameters are estimated synchrophasor measurement units (PMUs) of buses nearer to generators. The proposed scheme has been implemented on the two-bus power system with a source at Bus-1 and load at Bus-2 in the MATLAB/Simulink environment. To show the dependability and security of the proposed backup protection function, the current index and power factor estimated using PMU measurements of the bus nearer to sending end are used. The results show that the proposed function does not depend on the direction of current flow and fault parameters. Thus, the proposed protection is suitable to realize dependable numerical protection.

Logarithmic Absolute Square Error Based Differential Protection Scheme for AC Microgrid

Chandan kishore (Indian Institute of technology Roorkee); Manoj Tripathy (Indian Institute of Technology,Roorkee)*

Abstract: Differential protection offers better selectivity and performance for distribution networks integrated with microgrid. However, its effectiveness can be impacted by the high impedance fault, noise, measurement error and effect of time synchronization error. Therefore, this paper proposes a Logarithmic Absolute Square Error (LASE) based differential protection scheme for AC microgrid, utilizing the phase current magnitude as fault detection parameter. The proposed differential scheme calculates the Superimposed Phase Current Magnitude (SPCM) at local ends of the line, triggering the protection scheme when the SPCM exceeds disturbance alarm indicator at both line ends. The LASE based approach computes the log of the square of the absolute difference of SPCM, calculated at both ends of the line. This square approach enhances sensitivity, i.e. enabling fault detection up to 600 Ω in both grid and islanding operating modes of AC microgrid, while also facilitating faulty phase identification. To prevent undefined values in logarithmic calculations when the difference is zero, a constant factor (unity value) is incorporated into the LASE scheme. The proposed scheme is applicable to various network configurations i.e. mesh, ring and radial. It is stable for different system transients, external faults and is insensitive to noise, measurement error and time synchronization error effects. The LASE based scheme has high accuracy and provides fast fault identification (1.5ms-19.15ms for 50Hz). A comparative analysis of the LASE based scheme is also performed with the recent schemes to highlight its superior speed, sensitivity, and selectivity.

PMU Placement to Estimate Power Mismatch for Frequency Stability Assessment

Baity Nuris Syifa (The University of Queensland); N Mithulananthan (The University of Queensland); Rakibuzzaman Shah (Federation University Australia); JiaJie Feng (The University of Queensland)*

Abstract: The increased penetration of Inverter-Based Renewable Resources (IBRs) to replace fossil fuel-based Synchronous Generators (SGs) presents significant stability challenges, such as frequency stability. This issue arises primarily from the reduction in system inertia, as Renewable Energy Sources (RESs) provide little to no inherent inertia. Consequently, the Transmission System Operator (TSO) has a shorter time window to implement corrective actions to prevent frequency excursions from exceeding regulatory limits and avoid frequency collapse. These excursions include rapid changes in

frequency, such as the Rate of Change of Frequency (RoCoF), and a decline in frequency nadir following a major system disturbance. Estimating the disturbance size immediately after the event is crucial for remedial action, allowing TSO sufficient time to take preventive control actions. This paper proposes an estimation method using the Active Current Frequency Sensitivity Index (ACFSI), which helps identify the most sensitive buses critical for optimal Phasor Measurement Unit (PMU) placement, resulting in accurate disturbance size. The effectiveness and precision of the proposed method are assessed by conducting simulations on the IEEE 39 bus system with various outages.

SPECIAL SESSION 3:

Transformative Solar Energy Solutions for Next-Generation Power and Mobility

A Comprehensive Study of Ground Mount and Floating Solar PV System Performance in India for Electric Vehicle Green Charging

Mukul Banerjee (National Institute of Technology Mizoram); Sourav Saha (National Institute of Technology Mizoram); Sukanta Roy (National Institute of Technology Mizoram)*

Abstract: Energy scarcity reduces people's quality of life and obstructs progress in many places globally. EV are becoming increasingly important as governments worldwide shift to a green energy economy due to their ability to reduce emissions from the transportation sector. The system experiences a considerable power interruption whenever EVs get charged at charging stations connected to the grid. This study examines the performance, efficiency, and site selection of floating and ground-mount solar PV plants to generate electricity for charging stations. The economic and environmental performance of the system and novel applications for power systems powered by renewable energy that use floating solar photovoltaics are examined. EV charging systems powered by solar photovoltaics offer both technological and ecological viability. According to the findings, smart charging and vehicle-to-grid technology significantly decrease energy storage needs in nations with sizable fleets of electric vehicles. This study presents a viable route towards environmentally friendly transportation in India's changing environment.

A Hybrid MPPT Approach for BLDC Motor Speed Control Using Adaptive pi and Boost Converter

G. Jawahar Sagar (SRM University AP); V.Vivek Nag (SRM University AP); Tarkeshwar Mahto (SRM University AP); Sivamshu Nagalingam (SRM University AP); V Badrinath (SRM University AP); Pratikanta Mishra (SRM UNiversity AP)*

Abstract: MPPT is crucial for optimizing the efficiency of PV systems. However, conventional methods such as Perturb and Observe (P&O) and Incremental Conductance (I&C) suffer from slow convergence, steady-state oscillations, and failure to track the global maximum power point (GMPP) under partial shading conditions (PSC). To address these limitations, this paper proposes a hybrid MPPT strategy integrating Incremental Conductance (I&C) and spider Monkey Optimization (SMO). The I&C method ensures rapid tracking under uniform irradiance, while the SMO algorithm is activated under PSC to identify the true GMPP, overcoming local maxima issues. The extracted power is regulated using a boost converter to charge a battery, which supplies an inverter-fed Brushless DC (BLDC) motor. A closed-loop PI controller with an adaptive mechanism ensures precise speed control, minimizing torque ripples and enhancing system stability. Simulation results validate the proposed approach, demonstrating higher MPPT efficiency, reduced power loss, and improved motor performance under dynamic conditions. The proposed system enhances the reliability of solar-powered BLDC motor drives, making it a viable solution for electric vehicle and industrial automation applications.Several hybrid MPPT strategies have been explored in literature, including combinations of I&C withHybrid MPPT strategies have been explored, combining I&C with Particle Swarm Optimization (PSO), Genetic Algorithms, and Grey Wolf Optimization (GWO), each addressing various trade-offs between speed and global accuracy. Compared to these, SMO offers a better balance of exploration and convergence control.

Parametric Analysis of Recent Hybrid BIPV Array Configurations for Power Loss Mitigation under Non-uniform Shading Situations

*Debayan Sarkar (NIT Silchar)**

Abstract: Building-integrated photovoltaics (BIPV) is one of the greatest ways to use solar energy, which is currently the most plentiful, renewable, and clean energy source available. A technically sound and financially profitable solution for a building's electrical independence is adopting BIPV technology. This one is one of the most promising solar energy harvesting technologies for cities. When partially

shaded, solar PV arrays have an issue with heating and hotspot formation. The traditional series-parallel array architecture has a problem with efficiency degradation under partial shade conditions (PSCs). Hybrid Series-parallel & total-cross-tied (S-P & T-C-T), honey-comb & total-cross tied (H-C & T-C-T), and bridge linked & total-cross tied (B-L & T-C-T) are a few of the 10×10 hybrid designs that were selected. In this paper, the effects of these hybrid array designs are examined. These hybrid designs' effects are examined in terms of their topological and performance characteristics. The MATLAB/Simulink R2019b is used to model and test the hybrid configurations using the BIPV module available. Under various PSCs, the performance of hybrid setups is evaluated by assessing power generation at the global maximum power point (GMPP), mismatched power loss (MPL), efficiency and fill factor (FF) in each configuration under various PSCs.

Design And Simulation For A Full Bridge LLC DC-DC Converter For EV Charging Application

Pradeep B (Student); Lenin Prakash S (Assistant Professor); Subanesika R (Student); Sahana M (Student)*

Abstract: The increasing adoption of electric vehicles (EVs) necessitates for a high efficiency high power density EV charging system (EVCS). Full Bridge LLC DC-DC converter FBLLC topology is one of the preferred topologies for an EVCS to achieve high efficiency & high-power density. This paper proposes to develop a FBLLC DC-DC converter for a EVCS application. The design of magnetics for a FBLLC converter in-order to achieve Zero Voltage Switching (ZVS) operation, involves a complex iterative procedure considering multiple constraints and trade-offs. The design procedure considering multiple such factors which in turn affects the performance indices such as efficiency, power density and electromagnetic compatibility (EMC) has been presented in detail. The design has been validated with MATLAB simulations and the results has been presented. Also, the simulation results of the FBLLC DC-DC converter working in constant current and constant voltage mode for an EV charging application has been presented.

Cost of Charging in a Solar Modules Integrated Electric Vehicles

Suresh Reddy Mekapati (National Institute of Technology SIlchar); Nalin Behari Dev Choudhury (National Institute of Technology SIlchar)*

Abstract: Generally, Electric vehicles (EVs) generate the economy by participating in grid support by discharging their battery. Again, charging the battery of the EVs depends on the grid. Solar Module integrated EVs are another type of EVs that mounts the PV modules onto the upper surfaces of the vehicle body and charges the EVs (SIEV) battery when the sunlight is available, irrespective of the location. SIEVs gains economy in both ways, like discharging and charging via self-placed PV modules leads to revenue gained and results in reducing the cost of charging. In this article, the cost of charging by the SIEVs during different seasons in different conditions, like shading and unshading conditions, are analyzed for the location chinthalacheruvu located in a badvel town, Andhra Pradesh, situated in the southern region of India for the year 2020.

SPECIAL SESSION 4:

Stationary and Mobile battery storage for Advancing grid Resilience and Flexibility

Grid-Forming Control for Edge-Based DERs: Integration Strategies and Performance in Weak Grids

*Harendra Pal Singh (College of Technology Pantnagar)**

Abstract: The integration of inverter-based Distributed Energy Resources (DERs) into weak grids presents stability challenges due to low inertia and high impedance, leading to voltage and frequency fluctuations. To enhance system resilience, Grid-Forming (GFM) and Grid-Following (GFL) inverters are used together, ensuring effective voltage and frequency regulation. GFM inverters emulate traditional synchronous generators, providing grid stability, while GFL inverters optimize power exchange using phase-locked loop (PLL) synchronization. This study analyzes the performance of DERs in the IEEE 15 bus radial distribution network under steady-state and transient conditions. A key aspect is the seamless transition of an islanded microgrid to grid-connected mode, which is crucial for maintaining reliability during grid disturbances or planned islanding. The case study is implemented in MATLAB/SIMULINK using m-file scripts for system modeling and control. The transient analysis evaluates the impact of inverter control strategies on the stability, voltage regulation, and frequency response of the microgrid. The results provide insights into improving the integration of DER, improving power quality, and ensuring robust operation in weak grids. This research contributes to the development of advanced inverter control techniques that support the stable and efficient operation of modern distribution networks with high DER penetration.

Quantum Computing for Enhanced Material Discovery and Optimization in Electric Vehicle Batteries

O.Yaswantha Reddy (SRM University AP); G. Jawahar Sagar (SRM University AP); Tarkeshwar Mahto (SRM University AP); Amit Kumar Yadav (SRM University AP); Anand Kumar (Vellore institute of technology Chennai); Manoj Kumar Kar (Tolani Maritime Institute Pune Maharashtra)*

Abstract: The urgent need for high-performance, sustainable electric vehicle (EV) batteries has driven the exploration of advanced computational methods to accelerate material discovery. Traditional approaches, such as Density Functional Theory (DFT) and Hartree-Fock, face inherent limitations in simulating the complex quantum behaviors of novel battery materials. This paper introduces a pioneering framework leveraging quantum computing, specifically the Variational Quantum Eigen solver (VQE), to overcome these challenges and optimize solid-state battery materials. We focus on Lithium Thiophosphate (Li3PS4), a promising electrolyte for next-generation batteries, and demonstrate how quantum simulations can provide a deeper understanding of electronic structures and electrochemical reactions at an unprecedented level of precision. By benchmarking quantum results against classical methods, we highlight the transformative potential of quantum algorithms to capture intricate electron correlations and reaction dynamics, offering more accurate predictions for material performance. Our findings suggest that quantum computing not only offers a significant leap in the accuracy of battery material simulations but also paves the way for scalable, data-driven optimization of next-generation energy storage systems.

A Novel Hybrid Islanding Detection Technique for PV-Battery DC Microgrid

Kunal Singh (IIT BHU); Avirup Maulik (IIT BHU); MK Verma (IIT BHU); SR Mohanty (IIT BHU)*

Abstract: A hybrid islanding detection technique for a DC microgrid is presented in this paper, in which a novel passive index (cumulative product of superimposed voltage) is proposed for disturbance identification in the first stage (passive). The second (active) stage discriminates between islanding and non-islanding disturbances and is activated if the proposed passive index exceeds a threshold. The computation of the proposed passive index is simple, requiring only voltage measurements, making the proposed approach fast and easily implementable. Simulation studies verify that the proposed technique

can successfully discriminate between islanding and non-islanding events, quickly detect islanding under zero power mismatch scenarios, and improve power quality.

Battery RL: Deep Q-Network for Intelligent Battery Management in Smart Grid Environment

*Muhammad Zia (American University in Dubai)**

Abstract: Battery storage plays a vital role in the emerging smart grid, offering the unique capability to rapidly respond to renewable generation fluctuations and grid disturbances. However, research on profitably leveraging this capability remains limited. Effective solutions must account for the intermittent nature of real-time energy prices, electricity markets and adaptation to price fluctuations. Reinforcement Learning has demonstrated the potential to optimize complicated decisionmaking under probabilistic scenarios. This study proposes a Deep Q-Network (DQN)-based Battery Trading System (BTS) to optimize charging and discharging decisions based on real-time electricity prices. The environment was first designed, defining the states, actions, reward function, and DQN agent. The agent was then trained through exploration and exploitation within the environment. Additionally, hyperparameters were analyzed against the cumulative reward or performance of BTS. The proposed approach was benchmarked against a baseline Mixed Integer Non-Linear Programming model and random agent. The results demonstrate that the DQN-based agent generates the same revenue as the baseline model which assumes to have prior knowledge of future states and is not possible in reality. Furthermore, the feasibility of the proposed approach is validated using economic, computational, and adaptability metrics, highlighting its effectiveness for real-world applications of battery trading systems.

Peer-to-Peer Energy Trading Framework for Microgrid Community Considering Community Hybrid Energy Storage

Alok Kumar (IIT BHU); Avirup Maulik (IIT BHU); Chinmaya KA (IIT BHU)*

Abstract: Peer-to-peer energy trading enhances intra-community energy utilization and economic benefits in prosumer microgrids. This paper optimizes the operation of a microgrid community with profit-driven community hybrid energy storage using the Nash bargaining framework and dynamic bidding price-based peer-to-peer energy transactions. The decentralized, privacy-preserving optimization is validated on a microgrid community having three microgrids and a community hybrid energy storage system. Results show that dynamic bidding increases social welfare by ~18.16% and self-consumption by ~27.31% compared to the absence of peer-to-peer trading.

Performance Comparison of Conventional and Three level Buck-Boost converter for Efficient EV Charging Application

Vivek Singh (MNNIT, Prayagraj); Ankit Pratap Singh (MNNIT, Prayagraj); Shubh Lakshmi (MNNIT, Prayagraj); Souradip De (MNNIT, Prayagraj)*

Abstract: Electric Vehicle (EV) charging system requires efficient and reliable power conversion to ensure stable energy transfer while minimizing losses and component stress. This paper presents a comparative analysis of the conventional Buck-Boost Converter and the 3- level Buck-Boost converter for 48V EV charging applications operating at a 50KHz switching frequency. The 3-level Buck-Boost converter offer significant advantage of reduction in inductance and capacitance , lower voltage stress on switch and reducing switching losses leading to improve efficiency and thermal performance, Additionally, the voltage and current ripple reduces. These improvements make the 3-level Buck-Boost Converter more efficient, compact and reliable choice for high-power EV chargers. This study highlights the benefits of adopting multi-level converter topologies in modern EV charging infrastructure, optimizing energy conversion while maintain grid stability and battery performance.

A Comparative Study of Battery State of Charge Estimation Techniques

Shahid Akhtar Iqbal Ahmed (SVKM's Institute of Technology, Dhule); Himanshu Bhamare (SVKM's Institute of Technology, Dhule); Tanishka Jadhav (SVKM's Institute of Technology, Dhule); Kalyani Rajput (SVKM's Institute of Technology, Dhule); Bhargav Patil (SVKM's Institute of Technology, Dhule); Vishal Moyal (SVKM's Institute of Technology, Dhule)*

Abstract: Effective energy management in electric vehicles and renewable energy storage systems requires State of Charge estimation of batteries. In this paper, the effectiveness and reliability of the Kalman Filter Method (KFM) and the Coulomb Counting Method (CCM) for State of Charge (SoC) estimation are evaluated. The current sensor drift and State of Charge initial dependency make Coulomb Counting a simple but error-prone approximation. A change monitoring and battery model are employed within the Kalman Filter to provide error correction in estimation. Simulation results show that the KMF is feasible for real-time battery monitoring and performs better under dynamic operating conditions.

SPECIAL SESSION 5:

Artificial Intelligence and Machine Learning for Smart, Resilient, and Sustainable Energy Systems

Machine Learning-Based Backup Protection for Wind Farm Integrated Transmission System

Nilesh Kumar Rajalwal (BIT Mesra); Sonal "S" (BIT Mesra); Debomita Ghosh (BIT Mesra)*

Abstract: The primary distance relay protects up to 80% of line length. However, backup protection is provided for the next section of line in zone-II and zone-III of the distance relay. If the backup protection fails, the system may observe cascaded tripping. This paper proposes a backup protection scheme for fault classification and location identification in a wind farm-integrated transmission network. For this reason, the IEEE 14 bus system is modified and modeled in PSCAD/EMTDC software and simulated for faults at various locations for collecting high-resolution voltage measurements. Voltage measurements are utilized for determining the discrete wavelet transform (DWT). The DWT coefficients are used for feature extraction and feature selection for fault classification and location identification. A comparison between the accuracy and speed of two popular classification approaches support vector machine (SVM), and k-nearest neighbors (K-NN) has been made for fault type and location identification.

Hybrid Optimization Using Particle Swarm Optimization and Gradient Descent to Improve Phase Locked Loop Performance in Grid Connected Systems

Mrinal Rajak (National Institute of Technology Arunachal Pradesh); Roshan Kumar (National Institute of Technology Arunachal Pradesh); Rajen Pudur (National Institute of Technology Arunachal Pradesh)*

Abstract: This paper presents a novel Hybrid Particle Swarm Optimization and Gradient Descent (PSO-GD) based Phase- Locked Loop (PLL) for enhanced grid synchronization in power inverter systems. Unlike conventional fixed-parameter PLLs, the proposed approach adaptively optimizes controller gains through a unique combination of PSO's global search capabilities and GD's local refinement precision. Comprehensive performance comparisons with traditional methods including SRFPLL, DDSRF-PLL, and MSOGI-PLL demonstrate the superior capabilities of the hybrid approach under various grid disturbances. When subjected to 30% voltage sags and 30° phase jumps, the Hybrid PSO-GD PLL maintains frequency deviations within ±0.3 Hz and phase tracking errors below 3 degrees, while achieving a 40% reduction in settling time compared to conventional methods. The enhanced stability margins (65° phase margin, 12 dB gain margin) and improved bandwidth (120 Hz) ensure robust operation during grid disturbances, while maintaining THD below 1.7%. Detailed experimental results verify the effectiveness of this adaptive approach, particularly for modern grids with high renewable energy penetration where frequent disturbances demand real-time parameter optimization. The proposed method offers a promising solution for improving grid synchronization reliability and power quality in renewable energy integration applications.

Artificial Intelligence-Powered Real-Time Network Intrusion Detection System with Large-Scale Data Processing in Cloud Environments

Akshay Sharma (Sagitec); Bhushan Balkrishna Chaudhari (Independent Researcher); Satish Kabade (Independent Researcher)*

Abstract: Nowadays, more and more people are becoming aware of the security issues of computers. Traditional IDS (Intrusion Detection Systems) have the drawbacks of poor realtime performance and low accuracy. In response to this issue, this paper adopts an ML-based network intrusion detection algorithm. The system utilizes the CSE-CIC-IDS2018 dataset, which undergoes rigorous preprocessing, including duplicate removal, missing value handling, and Min-Max normalization to ensure high-quality input. Dimensionality reduction is performed using PCA techniques to enhance learning efficiency. A hybrid deep learning based LSTM-Petri Net (LSTM-PNet) architecture is employed with Adam optimizer and binary cross-entropy loss function as utilized hyperparameters. Training accuracy was 99.70%, and validation accuracy was 99.68%, both with minimum loss values, demonstrating

exceptional performance of the proposed model. Classification metrics indicate near-perfect precision, recall, and F1 scores across both benign and attack classes, supported by clear convergence in accuracy/loss curves and an interpretable confusion matrix. When benchmarked against traditional and deep learning models like Decision Tree, DNN, CNN, AdaBoost, and MLP-PSO, the proposed model consistently outperforms all others, underscoring its robustness and adaptability.

State-of-Charge Estimation of Lithium-ion Capacitors Combining Impedance data and Deep Neural Network

Arunabh Roy (NIT Silchar); Pankaj Saha (VTT Technical Research Centre Of Finland); Munmun Khanra (NIT Silchar)*

Abstract: Lithium-ion capacitors (LICs) are novel energy storage devices that are gaining popularity for combining the high energy density of lithium-ion batteries with the high power density of supercapacitors. Due to their hybrid nature, a significant challenge lies in the estimation of their State of Charge (SOC). SOC estimation is crucial in practical applications of LICs, as accurate estimation improves longevity, performance, and dependability by enabling efficient energy management. This work presents two proposed schemes utilizing impedance data and deep neural networks (DNN) for SOC estimation of LICs. Electrochemical Impedance Spectroscopy (EIS) data is collected for a 100F LIC across the entire SOC range, in 5% increments, at 25°. This raw EIS data is directly fed as input to the DNN-1 for SOC estimation scheme-1. Further, an Equivalent Circuit Model (ECM) is identified using the raw EIS data. Subsequently, the parameters of this ECM are used as inputs for the DNN-2 in SOC estimation scheme-2. The performance of both the schemes are validated and compared. Although, both the schemes perform satisfactorily, having an overall Root Mean Square Error (RMSE) (taking average RMSE of all the SOC points) less than 1.3%, the DNN trained with raw impedance data moderately outperforms the DNN trained with ECM parameters, achieving an overall RMSE of less than 1%.

Monitoring and Prognostics of Lithium-Ion Batteries Using Dual Gaussian Process Regression

Ilango Karuppasamy (Amrita School of Engineering, Amrita Vishwa Vidyapeetham); SHUBHASHRI V P (Amrita School of Engineering, Coimbatore, Amrita Vishwa Vidyapeetham, India); VARSHINI R (Amrita School of Engineering, Coimbatore, Amrita Vishwa Vidyapeetham, India); Shrinidhi Ganesh (Amrita School of Engineering, Coimbatore, Amrita Vishwa Vidyapeetham, India)*

Abstract: Monitoring and predictive modelling of lithiumion battery performance are critical for advancing energy storage technologies. This study employs a Dual Gaussian Process Regression (GPR) framework to model both State of Health (SOH) and Remaining Useful Life (RUL) by leveraging indirect health indicators derived from voltage, current, and temperature data in the NASA lithium-ion battery dataset. Three predictive models are evaluated to account for both linear and nonlinear degradation patterns. Among these, Model 3 demonstrates the highest accuracy, achieving an RMSE of 0.0040 for SOH and an MAE of 12.4499 for RUL on battery B0005. By integrating capacity degradation with indirect health indicators, Model 3 offers a robust and reliable framework for battery performance prediction. Future work can explore the inclusion of additional health indicators to further enhance predictive accuracy.

Artificial Intelligence-Based Comparative Analysis of Wind Energy Forecasting Models

Arpan Das (Gurunanak Institute Of Technology); Dr. Barnali Kundu (Gurunanak Institute Of Technology)*

Abstract: Accurate wind energy predicting is essential for optimizing power grid stability, energy trading, and renewable energy integration. This study explores the performance of eight machine learning models—Linear Regression, Random Forest, Support Vector Machine (SVM), Artificial

Neural Network (ANN), XGBoost, LightGBM, CatBoost, and Long Short-Term Memory (LSTM)—to predict wind power generation. The models were evaluated based on key performance metrics, including Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and R^2 score. Experimental results indicate that ensemble learning methods, particularly XGBoost, LightGBM, CatBoost, and Random Forest, achieved near-perfect predictions with an R^2 score of 1.0000, significantly outperforming other models. ANN also demonstrated strong predictive capabilities with an R^2 score of 0.9853, whereas traditional regression and SVM struggled with higher errors. LSTM, expected to excel in time-series forecasting, failed with an R^2 score of -0.9126, showing poor generalization. The findings highlight the superiority of ensemble models for wind energy forecasting, providing a robust solution for improving grid efficiency and renewable energy utilization.

A Robust Machine Learning Approach for AC Microgrid Fault Diagnosis Using FFT and XGBoost

Dr.Rudranarayan Pradhan (Odisha University of Technology and Research, Bhubaneswar, Odisha); Sibani Sen (Odisha University of Technology and Research, Bhubaneswar,Odisha); Jyotishree Behera (Odisha University of Technology and Research, Bhubaneswar,Odisha); Tapan Kumar Sahoo (National Institute of Technology, Warangal)*

Abstract: The increasing penetration of renewable energy sources in AC microgrids necessitates intelligent and data-driven fault diagnosis techniques to maintain system stability and reliability. This paper presents a novel fault detection and classification framework utilizing Fast Fourier Transform (FFT) for feature extraction and Extreme Gradient Boosting (XGBoost) for fault identification and classification. FFT transforms time-domain voltage and current signals into the frequency domain, enabling the extraction of critical features such as power spectral density (PSD), RMS, spectral entropy, and median frequency. These features are used to train the XGBoost classifier, known for its robustness, speed, and accuracy. The proposed method is validated on a seven-bus AC microgrid model simulated using RSCAD, encompassing various fault scenarios such as LG, LL, LLG, LLL, and LLLG. A comprehensive comparison with Decision Tree (DT), Random Forest (RF), and CatBoost models demonstrates the superior performance of XGBoost, achieving an overall accuracy of 99.72%. The results highlight the method's effectiveness and robustness in accurately detecting and classifying faults under diverse conditions, making it suitable for real-time deployment in intelligent microgrid protection systems.

Health Monitoring of Line Insulators Through Artificial Intelligence Based Surveillance System

Arjun M (North Eastern Regional Institute of Science and Technology); A Parida (North Eastern Regional Institute of Science and Technology); P Devachandra Singh (North Eastern Regional Institute of Science and Technology); D Chatterjee (Jadavpur University)*

Abstract: High-tension (HT) power line insulators are critical components of electrical transmission systems, and their failure due to cracks can lead to power outages and safety hazards. Traditional inspection methods are time-consuming, costly, and pose significant risks to the workers. This paper proposes an artificial intelligence (AI) based surveillance system for detecting insulator cracks. The surveillance system uses drones to capture high-resolution images of insulators and incorporates a target detection algorithm based on YOLOv11 (You Only Look Once), which utilizes the powerful learning ability of deep convolutional neural network (CNN) to classify the insulators as defective or non-defective. This method is trained on a large dataset of annotated samples. The experimental results show that the YOLOv11 based insulator defect detection method can effectively identify the defective insulators from the drone captured aerial images. Compared with the previous insulator defect identification methods, the accuracy and detection time are significantly improved. The proposed

solution offers a safer, faster, and more cost-effective alternative to manual inspections, with potential applications in large-scale power line monitoring.

Enhanced Speed Control of Hybrid Energy Source-based Switched Reluctance Motor Employing PSO-Tuned PI Controller

*Srijani Mukhopadhyay (National Institute Of Technology, Silchar)**

Abstract: This paper presents an efficient speed control strategy for a Switched Reluctance Motor (SRM) powered by a hybrid energy system consisting of photovoltaic (PV) panels and a battery storage unit. The proposed control methodology employs a Proportional-Integral (PI) controller optimized using the Particle Swarm Optimization (PSO) algorithm. The PSO-based PI controller ensures precise speed regulation under varying speed demands. The effectiveness of the system is evaluated through simulation results, demonstrating smooth speed tracking for dynamic speed variations from 1000 rpm to 1500 rpm, then back to 1000 rpm, and finally to 500 rpm. The results validate the robustness and adaptability of the proposed control strategy in maintaining desired speed profiles while efficiently managing energy from hybrid sources.

Digital Twin Based on Neural Network for a Grid Connected Modular Multilevel Converters for HVDC Transmission

*Ratna Raj (New jersey Institute of Technology)**

Abstract: Modular Multilevel Converters (MMCs) are the preferred voltage source converters for HVDC transmission in wind energy systems, and their effective lifecycle management is crucial for grid stability and reliability. Digital twin technology can be used to describe and model characteristics, behavior and real-world performance of complex systems by constructing real-time mapping of them which can be used for real-time and health monitoring. This paper presents a feed-forward neural network (FF-ANN) based digital twin (DT) for health monitoring of a grid-connected, MMC based inverter. Given the complex, non-linear dynamics of MMCs, a data-driven approach using an FF-ANN is well-suited for capturing the full system behavior. This work details the training data generation methodology, encompassing the diverse scenarios required for real-time modeling and health monitoring. By analyzing the difference between the digital twin's predicted output and the physical twin's actual output, this work demonstrates the model's accuracy in replicating system behavior under steady-state operation and during transient events, including AC and DC faults. The trained model can be used for health monitoring and can indicate parameter degradation.

Electricity Theft Detection using Ensemble-Based Machine Learning Classifier

Ashish Kumar (NIT Jamshedpur); Sanjay Mahto (NIT Jamshedpur); Niranjan Kumar (NIT Jamshedpur)*

Abstract: Power theft is still a major problem in the modern world, affecting the economy and the power system. It is mostly conducted using advanced techniques, such as illegal connection and meter tampering, that undermine the integrity of the power network and hinder attainable energy objectives. Machine learning methods based on ensemble learning, such as stacking classifiers, have been able to identify power theft. Improving accuracy and stability increases the efficiency of stacked classifiers to identify minor variations in electricity consumption patterns. It reduces false positives and increases the detection accuracy. In this research, for example, the Stacking classifier outperforms Decision Tree and Random Forest with an accuracy of 96%. It outperforms in terms of precision, recall, and F1-Score for normal and theft classes, particularly in identifying unauthorized connection and meter tampering. Decision Tree and Random Forest classifiers give 94% and 88% accuracies, respectively, but are unable to classify the theft into different classes. From the above analysis, the Stacking classifier outperforms other classifiers in improving the accuracy in detection and overcoming some theft patterns. This paper

highlights the potential of high-tech machine learning algorithms in combating power theft to guarantee energy system reliability and integrity across the globe.

Advancing Industry 4.0 with Cloud-Integrated Cyber-Physical Systems for Optimizing Remote Additive Manufacturing Landscape

*Mahi Ratan Reddy Deva (Independent Researcher)**

Abstract: The exponential development of digital technologies like the Internet of Things and Cyber-Physical Production Systems is the primary driver of the Fourth Industrial Revolution, sometimes referred to as Industry 4.0. The goal of this customer-driven CPS framework is to automate AM operations, make them more agile, and use customer needs data straight from the website. It also helps to construct a cloud-based, digitalized, remote system that combines Industry 4.0 technology. The widespread accessibility and ease of use of additive manufacturing (AM), also known as 3D printing, raise serious concerns about the theft of intellectual property (IP). The lack of physical interaction with the 3D printer is physical-to-cyber exploitation. This paper presents a cloud-integrated cyber-physical system for defect detection in additive manufacturing, leveraging deep learning models for enhanced quality control. A dual-model architecture using AlexNet and InceptionV3 was implemented and trained on a dataset of 1,557 3D printer images. Preprocessing techniques, including Discrete Wavelet Transform (DWT) for noise reduction and Contrast-Limited Adaptive Histogram Equalization (CLAHE) for contrast enhancement, were employed to improve image quality. The models were deployed in a cloud environment to enable monitoring and adaptive retraining. Performance evaluation demonstrated superior classification accuracy, with AlexNet achieving 99% and InceptionV3 97%, significantly outperforming baseline models such as ResNet101 (86%), VGG16 (95%), and DNN (82%). The solution adds to their understanding of how to automate, digitize, and provide agility to AM operations via the integration of Industry 4.0 technologies in a cloud-based, digital, and remote system. It lays forth a straightforward way to more intelligent manufacturing environments.

Smart Predictive Maintenance: AI-Driven Adaptation for Industrial Equipment

*Ashish Joon (Andhus Technologies Inc)**

Abstract: The fast growth of China's machinery manufacturing sector has resulted in many people's lives being easier. Many experts in the field pay close attention to the current state and future trajectory of the machinery manufacturing business because of the significant impact it has on the national economy. The machinery manufacturing sector has steadily raised its demands for suitable production technologies as social competitiveness has become more intense. This study proposes a machine learning-driven framework leveraging Deep Neural Networks (DNN) for fault detection and predictive maintenance using the MFP dataset. The data undergoes comprehensive preprocessing, including outlier detection, missing value handling, and normalization using robust scaling techniques. “Accuracy” (acc), “precision” (prec), “recall” (rec), “F1-score” (f-measure), and ROC-AUC (roc-auc) are vital performance measures that are used to train and assess the suggested DNN model. Results from experiments show that the DNN model reaches 93.21% accuracy which establishes strong performance over Deep Belief Networks (DBN), Random Forest (RF), and Isolation Forest. Moreover, the high AUC score of 0.978 validates that the model is sufficiently robust to discriminate between normal and faulty machinery conditions. Although the model has great predictive capability, it still faces computational costs and deploys in real-time problems.

A Machine Learning-Driven Oscillatory Mode Estimation Scheme for Smart and Sustainable Energy Systems Using Degraded PMU Measurements

Subhalaxmi Satapathy (National Institute Of Technology, Rourkela, Odisha, India); Shekha Rai (National Institute Of Technology, Rourkela, Odisha, India)*

Abstract: As modern power systems evolve with the growing penetration of renewable energy and dynamic grid operations, ensuring stability, resilience, and sustainability has become a critical challenge. Phasor Measurement Unit (PMU) driven Wide-Area Measurement Systems (WAMS) supplies real-time information which is essential to strengthen grid stabilty. However, PMU measured data is often corrupted due to loss of communications, malfunction of hardware, and cyber threats, leading to missing values, outliers, and noise, which hampers the stability and reliability of the power system. To tackle these challenges, this paper presents a machine learning-based scheme that integrates a Density-Based Spatial Clustering of Applications with Noise (DBSCAN) for removal of outliers with Graph Attention Network (GAT) for missing values imputation. DBSCAN locates the anomalous data points by preserving the PMU signals integrity, whereas GAT makes use of temporal dependencies in signal variations and spatial correlations among PMU nodes to restore the missing measurements correctly. Subsequent to the recovery process, the TLS-ESPRIT technique is employed to accurately evaluate the modal parameters, crucial for grid stability. The efficacy of the proposed scheme is checked by using a synthetic test signal and an oscillatory ringdown signal from the IEEE 39-bus system validated using a Real-Time Digital Simulator (RTDS). The results shows the potential of the proposed strategy in improving the automation of the power system, strengthening the grid resilience, and ensuring sustainable energy system operations.

Optimal Placement of Renewable Energy Sources and Fuel Cells in Power System Network

*Shakila Baskaran (NIT Nagaland)**

Abstract: With the growing diversity of distributed power systems, the integration of various energy sources, such as Solar Photovoltaic (PV) systems and Fuel Cells, has become increasingly common. These systems, while offering sustainability and efficiency, introduce challenges such as fluctuations in power input, voltage, current, and frequency. A stable power system must effectively manage these variations and distribute energy efficiently across subsystems. Stability can be enhanced by controlling critical parameters like reactive power, voltage, and frequency. This study investigates the stability of a distributed power system through load flow analysis and Line Stability Index (L-index) calculations, focusing on the IEEE 39-bus system as the base model. The study begins with a load flow analysis of the base system to identify weak points in the network. Solar PV and Fuel Cell systems are then integrated at the weakest bus to evaluate their impact on system stability under various operating conditions. The results highlight the ability of Solar PV systems to reduce L-index values and improve stability, though intermittency remains a challenge. In contrast, Fuel Cells provide consistent power generation, significantly enhancing voltage stability and reducing the risk of instability. This research underscores the importance of distributed energy resources in modern power systems, offering insights into improving grid performance and adapting to transient disturbances through strategic integration of renewable technologies.

Maximum Power Point Tracking of Solar PV System using Novel Hybrid Algorithm

*Shakila Baskaran (NIT Nagaland)**

Abstract: Solar energy is an important source of power, especially as energy demands grow and environmental concerns increase. However, extracting maximum power from photovoltaic (PV) systems is difficult because of the fluctuations in irradiance and temperature, which prevent them from achieving optimal energy output. The present study introduced a new way to track Maximum Power Point (MPPT) in solar systems, which is inspired on the unique behaviors by the Addax Antelope, known for its effective movement patterns. Our aim is to compare these different methods and to find out the most effective way to maximize the power extraction from the PV panels. Regulation of power and stability is achieved by using a Boost Converter and a Solar Charge Controller. Simulation results in MATLAB Simulink reveal that the AOA-based MPPT system has a faster convergence rate, less oscillation and higher tracking accuracy than the conventional methods. Among all the approaches

tested, the Hybrid P&O with AOA method promises the best performance with the highest power output delivered under the various conditions of the environment. The conclusions highlight the potential of AOA-based MPPT systems for maximizing extracted energy, minimizing power losses, and increasing in efficiency and reliability of PV systems that can make for a promising means of sustainable energy generation.

Artificial Neural Network Based Fault Detection and Classification in Power System

*Rupak Debnath (National institute of technology Agartala)**

Abstract: A continuous supply of electricity depends on the stability and dependability of power transmission infrastructure. If not identified and categorized right away, transmission line faults brought on by equipment malfunctions, environmental conditions, or short circuits can result in serious power outages. Traditional fault detection methods frequently depend on numerical and threshold-based approaches, which may not be accurate or quick enough in complicated fault situations. An Artificial Neural Network (ANN)-based method for fault detection and classification in high-voltage transmission lines is presented in this research in order to overcome these constraints. To simulate different kinds of symmetrical and unsymmetrical failures under diverse circumstances, a model based on MATLAB/Simulink is created. To classify faults, a Backpropagation Neural Network (BPNN) is trained using extracted and pre-processed voltage and current inputs. To effectively identify various defect kinds, a broad dataset is used to train the ANN model. To further improve accuracy and efficiency, future studies will investigate real-time hardware implementation and sophisticated deep learning techniques.

Assessment of optimum operating state of HVDC converters under uncertain operating condition of hybrid AC-DC power system through a stochastic optimization based approach

Chintan Patel (National Institute of Technology Silchar); Dr. Tanmoy Malakar (National Institute of Technology Silchar); Dr. Sreejith S (National Institute of Technology Silchar)*

Abstract: In previously reported studies on optimal power flow (OPF) in hybrid AC-DC systems, the assessment of the operating state and its effect on converter operation and performance is mostly ignored. Further, the uncertainty involved with renewable energy sources (RES) affects the state variables (SV) of the direct current (DC) link side, and the study on its implication on converter performance is unexplored. Hence, in this study, converters' operating state and performance under uncertain RES power and load demand are assessed through a stochastic optimal power flow (SOPF) based approach. The expected generation cost, including overestimation and underestimation penalty, is considered as an objective function. The simulation study is carried out on a modified IEEE 30 bus system, and the honey badger algorithm (HBA) is utilized as an optimization tool. The probability distribution (PD) of firing angle, power factor (PF), ripple factor (RF) etc. are evaluated through Monte-Carlo simulation, and assessment of them in terms of mean, range, and spread is presented. For instance, at the rectifier end, the values of PF and RF range between 0.974 to 0.984 and 0.068 to 0.082, with 0.979 and 0.075 as mean values respectively. A comparison with other reported results indicates the robustness of the proposed method in achieving better converter performance under uncertain conditions.

Predictive Models for Voltage Degradation in PEM Fuel Cells Using Gradient Boosting and LSTM Networks

Kadwe Tanuja Pravin (Amrita Vishwa VIdyapeetham); Swetha Promod M (Amrita Vishwa Vidyapeetham); Rahul Satheesh (Amrita Vishwa Vidyapeetham); Sreenu Sreekumar (Amrita Vishwa Vidyapeetham); Mohan Lal Kolhe (Amrita vishwa Vidyapeetham)*

Abstract: The reliability and operational effectiveness of Proton Exchange Membrane Fuel Cells (PEMFCs) are significantly affected by voltage degradation. To predict voltage degradation in PEMFCs, this study focuses on data-driven approaches that employ machine learning (ML) and deep learning (DL). The research demonstrates how Long-Short Term Memory (LSTM) networks outperform other approaches by training models such as gradient boost regressors, neural networks, and LSTM networks through large PEMFC voltage datasets. Gradient boost regressors and other ML models are not particularly efficient at capturing long-term dependencies, and while LSTM networks are more efficient at controlling temporal patterns, they still require a lot of computational resources and precise hyperparameter tuning. Nevertheless, despite these challenges, integrating these models provides more scalable and accurate prognostics than traditional physics-based techniques, making them highly beneficial for enhancing PEMFC operational efficiency while promoting the greater installation of renewable energy resources.

SPECIAL SESSION 6:

Hydrogen Fuel Cells and Hybrid Electric Vehicles: Innovations in Control, Design, and Policy for Sustainable e-Mobility

Modified Current Reference Generation Method for Minimizing Active Power Oscillations During Asymmetrical Low-Voltage Ride-Through (ALVRT) in Grid-Tied PV-Fuel Cell Systems

Abhishek Singh (NIT Silchar); Dinesh Kumar Tiwari (NIT Silchar); Nalin Behari Dev Choudhury (NIT Silchar); Jiwanjot Singh (NIT Silchar)*

Abstract: In recent updates to grid codes, various regulations for multiple countries have been updated to improve the reliability and robustness of power systems. One of these regulations is Low Voltage Ride-Through (LVRT), which states that photovoltaic (PV) systems must maintain continuous connection to the utility grid in the event of voltage sags at the Point of Common Coupling (PCC). This work is dedicated to the injected power oscillations at the PCC location, especially for asymmetrical voltage sag conditions, where the presence of negative sequence components gives rise to oscillations at twice the grid frequency. A modified reference generation strategy of currents based on the synchronous reference frame is developed to reduce these effects. Using the newly defined factor to realize the voltage unbalance factor (VUF) along with the gain parameter m, the proposed method is found to significantly reduce oscillations. It reduces the overall content of imbalance in the system and prevents overvoltage in healthy phases while reducing power oscillations. Additionally, the gain factor helps to limit the ripples of the DC link voltage, thus contributing to improving the lifespan of the capacitor. This study is consistent with the requirements of the Indian grid code, considering the standards for reactive current injection. The proposed control scheme is tested with the help of MATLAB/Simulink simulations.

ANN Based Sampling Time Selection Criterion for Model Predictive Controlled Multilevel Converter

Dinesh Tiwari (NIT Silchar); Abhishek Kumar Singh (NIT Silchar); Nalin Behari Dev Choudhury (NIT Silchar); Jiwanjot Singh (NIT Hamirpur); Ganji Ramudu (Aditya University)*

Abstract: Model Predictive Control (MPC) is a widely used technique for controlling power converters, but its performance is highly dependent on the appropriate sampling time selection. In high-frequency applications like the nine-level (9L) multi-winding transformer-based boost multilevel converter, improper sampling time selection can lead to increased total harmonic distortion (THD), higher switching losses, and poor dynamic response. This paper investigates the impact of sampling time on the output waveform quality of the converter. It proposes an approach based on artificial neural networks (ANN) to optimize sampling time selection. A comprehensive comparative study is conducted using MATLAB/SIMULINK to analyze the performance of different sampling times on voltage regulation, THD, and computational efficiency. The results demonstrate that selecting an optimal sampling time significantly enhances waveform quality while reducing switching stress and losses. Furthermore, this study highlights the importance of adaptive sampling time selection in MPC-based power converters and presents a data-driven solution for improved performance in high-frequency applications.

Improving Grid Stability and Balancing Renewable Power Intermittence with P2H2P Hybrid Power Systems Model: A Performance Study

Ashok Ghosh (University of Wollongong); Rabiul Islam (University of Wollongong); Raad Raad (University of Wollongong); Shuvra Prokash Biswas (University of Wollongong)*

Abstract: The energy landscape is shifting towards renewable energy sources (RES), phasing out fossil-fueled synchronous generators and integrating more inverter-based generators (IBG) into the grid. This transition poses significant risks to power system stability due to the inherent variability of renewable resources (VRR), low system inertia, and insufficient system strength, creating substantial barriers to achieving a fully renewable grid. Current technologies, such as battery energy storage

systems (BESS), are commonly employed to balance VRR, while traditional technologies like synchronous condensers (SC) provide system strength and inertia to support the grid and adhere to grid codes. These solutions have notable limitations, including high costs, operational complexity, time limits, and capacity constraints. Furthermore, this supportive solution functions as an individual mechanism rather than as an integral part of the system. This paper introduces an innovative power-to-hydrogen-to-power (P2H2P) hybrid model to tackle these challenges, featuring the Wärtsilä 31H2 pure hydrogen engine developed by Wärtsilä. This model aims to generate power from green hydrogen, supporting the grid during frequency and voltage disturbances without relying on established BESS or SC while ensuring a grid rich in 100% renewable energy. The model is tested within an IEEE 9-bus system to evaluate its performance, with results regarding bus voltage, active power, and reactive power for each bus in the 9-bus model presented. All simulation analyses are conducted within the DigiSILENT software environment.

Eliminating Cascaded Control Loops: A Neural Network Approach for Grid-Forming Inverters

Mitikiri Sagar Babu (IIT ISM Dhanbad); Amrutha Raju Battula (IIT ISM); Dushyant Sharma (IIT ISM); Vedantham Lakshmi Srinivas (IIT ISM); Mayukha Pal (ABB)*

Abstract: Grid-forming inverters (GFMIs) are fundamental in ensuring voltage and frequency stability in islanded microgrids. Traditional control architectures rely on cascaded voltage and current control loops, which require precise tuning and may exhibit limitations in dynamic response and adaptability. In this work, we propose a neural network-based control strategy that eliminates the conventional voltage and current control loops, directly generating the modulation index in the dq frame of reference. This approach simplifies the control structure while enhancing adaptability to system variations. The neural network is trained to learn the nonlinear mapping between system states and optimal modulation signals, resulting in improved transient response and robustness against disturbances. Simulation results demonstrate that the proposed methodology achieves the expected system behavior and maintains a low mean squared error (MSE = 3%), ensuring stable and reliable operation. The findings indicate that neural network-based control offers a promising alternative to conventional methods, paving the way for intelligent inverter control in resilient microgrids.

Ideal Location For Dg To Advance Their Voltage Profile Using Statcom And Renewable Vitality Sources

*Nasim Khan (Aliah University)**

Abstract: Integration of photovoltaic (PV) inverters within power distribution networks using static synchronous compensators (PV-STATCOM) during night time has currently been explored as a method to enhance network performance. The strategic placement of PV-STATCOM devices in distribution systems aims to simultaneously reduce electrical energy losses and enhance voltage profiles while considering fluctuating 24-hour load conditions. The influence of installing different numbers of PV-STATCOM units on distribution networks is examined. Virtual STATCOM is widely recognized for improving the voltage stability of weak buses in an 8-bus system. This study focuses on the modeling and simulation of a closed-loop controlled three-phase voltage source inverter-based Virtual STATCOM within such a system. The performance of Virtual STATCOM is analyzed using closed-loop PID and Model Predictive Control (MPC) strategies, and their respective outcomes are compared. The comparison is based on time-domain response parameters such as peak time, rise time, settling time, and steady-state error, using MATLAB. Additionally, the study evaluates real and reactive power performance, in addition to general harmonic distortion (THD) at every bus within the network.

Mitigation of DC Bus voltage Oscillations in Cascaded Systems of DC Microgrids: A Novel Source-Side Virtual RL Damper Approach

Satadal Bhowmik (Indian Institute of Technology (Indian School of Mines), Dhanbad); Gauri Shankar (Indian Institute of Technology (Indian School of Mines), Dhanbad); Suryakant Kumar (Indian Institute of Technology (Indian School of Mines), Dhanbad); R.K. Saket (I.I.T. (BHU) Varanasi)*

Abstract: Point of load (POL) converter are usually designed to deliver a stable output voltage which makes them ideal to power the downstream loads in cascaded DC-DC converter systems in DCMGs. By maintaining tight regulation of their output voltage, these converters dynamically adjust their input current to meet the constant power demand within their specified control bandwidth. As a result, the input of the POL converter feeding any DC/AC loads demonstrates the constant power behaviour as like a constant power load (CPLs). When these POL converters are connected to any type of distribution network via a suitable source converter, then their negative incremental impedance feature can destabilize the system in terms of severe voltage oscillations at the DC bus. This is due to its impedance interaction with that of the source converter. To mitigate the DC bus voltage oscillations caused by CPLs, this paper introduces a novel source side adaptive parallel virtual resistive-inductive (APVRL) damper using a dependent current source approach. The proposed control topology ensures accurate regulation and robust performance, even during sudden voltage supply fluctuations. Additionally, it supports plug-and-play functionality for CPLs. A theoretical analysis is conducted to evaluate the control and operational principles of the circuit implemented using the proposed technique. The study also explores the physical significance of the circuit in cascaded systems consisting of basic DC/DC converter buck converter supplying CPLs. The proposed active stabilizer is validated through simulations conducted using MATLAB®/Simulink software which demonstrates its effectiveness and reliability.

A Novel Source-Side Virtual RLC Damping Approach to Mitigate DC Bus Voltage Oscillations in Cascaded System of DC Microgrids

Satadal Bhowmik (Indian Institute of Technology (Indian School of Mines), Dhanbad); Gauri Shankar (Indian Institute of Technology (Indian School of Mines), Dhanbad); Suryakant Kumar (Indian Institute of Technology (Indian School of Mines), Dhanbad); R.K. Saket (I.I.T. (BHU) Varanasi)*

Abstract: Point-of-Load (POL) converters are specifically designed to provide a consistent output voltage to power downstream DC/AC loads. By tightly regulating their output voltage, they dynamically adjust their input current to satisfy the constant power demand within their appropriate control bandwidth. As a result, the input of the POL converter exhibits constant power behaviour which effectively operates as a constant power load (CPL). When POL converters are integrated into a distribution system through an appropriate source converter then their negative incremental impedance can destabilize the system which leads to voltage oscillations in the DC bus. This occurs due to the impedance interaction between the POL and the source converters. To address the DC bus voltage oscillations (DCBVO) induced by CPLs (CPL), this paper proposes an innovative control strategy known as the source-side adaptive virtual resistance-induced capacitive (AVRLC) mechanism. Here, a virtual RLC damper is connected parallel to the capacitor of the source converter. The proposed approach facilitates an easy and intuitive configuration of control parameters which ensures that the dynamic performance of the load converter remains uncompromised. The proposed AD control dynamically adapts to variations in load current, thereby, improving its flexibility and overall performance. This proposed control strategy is implemented using the proposed technique for three cascaded systems comprising basic DC/DC converters supplying CPLs (CPLs). The effectiveness of the proposed active stabilizer is validated through simulation in MATLAB®/Simulink software.

Hierarchical Attention-Enhanced Transformer Framework for Prognostic Degradation Modeling and Capacity Estimation of Lithium-Ion Batteries

Sk Bittu (Indian Institute of Technology (Indian School of Mines) Dhanbad, Jharkhand); Sukanta Halder (Indian Institute of Technology (Indian School of Mines) Dhanbad, Jharkhand); NILANJAN DAS (Indian Institute of Technology (ISM), Dhanbad); Mousam Ghosh (North-Eastern Hill University, Shillong)*

Abstract: Precise prognostics of the Remaining Useful Life (RUL) of Lithium-ion (Li-ion) batteries are imperative for augmenting their reliability, safety, and operational efficacy, particularly in domains such as electric vehicles (EVs), renewable energy storage, and portable electronic devices. Conventional approaches frequently produce suboptimal battery health assessments because they fail to capture complex long-term correlations among essential metrics, such as voltage, current, and temperature. To address these challenges, this paper integrates a Denoising Auto-Encoder (DAE) and a Mixture of Expert (MoE) paradigms to present an improved Transformer-based neural architecture for battery capacity estimation and RUL prediction. The Transformer network effectively predicts short-term and long-term degradation patterns, while the DAE reduces sensor noise to enable improved feature extraction. Furthermore, by dynamically utilizing several specialized sub-models for improved representation learning, the MoE framework improves predictive accuracy. Data augmentation strategies are used to address the issues of data scarcity, guaranteeing a training sample that is more diverse and robust. Compared to standard models, the suggested approach can reduce Relative Error (RE) by up to 10%-20%, demonstrating its resilience in battery health prognostics.

Ultra-High Gain DC-DC Converter driven PMSM for Green Energy Application

Nilanjan Das (Indian Institute of Technology (Indian School of Mines), Dhanbad); Sukanta Halder (Indian Institute of Technology (Indian School of Mines), Dhanbad); Gaurav . (Indian Institute of Technology (Indian School of Mines), Dhanbad); Sk Bittu (Indian Institute of Technology (Indian School of Mines), Dhanbad)*

Abstract: This paper presents a non-isolated DC-DC converter topology incorporating a switched inductor-switched capacitor module, designed for integration with a Permanent Magnet Synchronous Motor (PMSM) drive system. A threephase 400V AC motor typically requires an inverter with a DC Bus voltage of approximately 560V DC. However, conventional battery sources operating within the 300–400V range are insufficient to directly supply this voltage, necessitating a stepup stage to ensure proper motor operation. Without adequate voltage boosting, the inverter output remains below the required level, leading to reduced torque, compromised performance, or failure to initiate motor operation. To address this challenge, the study introduces a high-gain multi-port DC-DC converter featuring having a switched inductor-switched capacitor, optimizing efficiency with minimal component usage. This topology enables a significant voltage step-up while ensuring enhanced performance in PMSM-based drive applications. PMSMs are selected due to their superior dynamic response, efficient torque production, and precise speed regulation. The proposed converter undergoes performance evaluation under four-quadrant operation, including regenerative braking modes. Simulation results, conducted in MATLAB/Simulink, confirm the effectiveness of the converter in facilitating PMSM operation, particularly in battery charging scenarios during braking, demonstrating its potential for advanced electric drive applications.

Techno Economic Assessment and Sizing Analysis of PV, Fuel cell and battery Microgrid using HOMER Pro

Rasmiranjan Swain (Nit Rourkela); Indrajit Sarkar (NIT Rourkela); Monalisa Pattnaik (NIT Rourkela)*

Abstract: This work focuses on the cost of energy (CoE) sensitivity analysis of PV and fuel cell based microgrid with battery energy storage system (BESS) to power a small residential apartment with average load demand of 15 kWh/day. Cost data for multiple microgrid components are incorporated into the simulation model enabling thorough evaluation of different system configurations. Various technical and economic parameters, such as fuel price fluctuations, PV and fuel cell efficiencies, and battery autonomy, are considered to assess their impact on system feasibility based on the Homer load following dispatch strategy. The proposed approach results in reduction of 4.29% in the total net present cost (NPC) and 5.1% in the levelized cost of energy, demonstrating improved economic viability. The study aims to provide insights to sizing and economic analysis of microgrid for reliable and cost-effective power providers in off-grid applications. Future efforts will concentrate on integrating advanced metaheuristic optimization algorithms, implementing smart energy management logic for optimal resource distribution, and experimentally validating the approach for more economical system sizing.

Hybrid Energy Management System Employing Hysteresis Control for DC Microgrid

*Nasim Khan (Aliah University)**

Abstract: With the continuous rise in global energy demand, there is an increasing focus on fossil fuel exploration. However, these energy sources are neither sustainable nor environmentally friendly. The depletion of fossil fuel reserves and their harmful impact on the environment have led to a shift toward Renewable Energy Sources (RES) such as solar and wind power. Combining these sources results in a Solar-Wind Hybrid Power System (SWHPS), which maximizes the benefits of both energy types. Proper utilization of these renewable resources is essential to reduce reliance on conventional power generation methods and ensure a sustainable energy supply. This work introduces a closed-loop quadratic boost converter-based DC microgrid that integrates renewable energy sources, energy storage systems, and different types of loads. The proposed control system is designed to maintain power balance and grid stability, even under variable environmental conditions and fluctuating loads, where certain power sources may not be fully controllable. A comparative evaluation is conducted between an open-loop DC microgrid system under disturbances and a closed-loop DC microgrid (DC-MG) framework utilizing Proportional-Resonant (PR) and Hysteresis Control (HC) techniques. These systems are modeled and simulated using MATLAB/Simulink, and their performance is analyzed based on parameters such as settling time and steady-state error. The results indicate that the controlled DC microgrid system performs better in minimizing harmonic distortion and ensuring a rapid dynamic response.

A Novel Three Phase Seventeen Level Inverter for Grid Tied PV Applications

Shivam Kumar Yadav (Harcourt Butler Technical University); Sanjiv Kumar (Harcourt Butler Technical University)*

Abstract: Multilevel Inverters (MLIs) have gained significant attention due to their compact and efficient design, making them well-suited for applications such as solar photovoltaic (PV) systems and power grids. This study introduces a novel three-phase, seventeen-level MLI topology that utilizes a switched capacitor (SC) approach with a common ground configuration to achieve an eightfold increase in input voltage. The number of output levels is determined by the parallel combination of SC1, SC2, and SC3 cells. Designed specifically for low-voltage PV systems, this Inverter eliminates the need for a separate boost DC/DC converter. Additionally, it is capable of handling reactive power, regardless of

whether the grid power factor is lagging or leading. A dedicated modulation strategy ensures that the switched capacitor voltages remain stable within acceptable ripple limits. To regulate power flow and maintain DC-link voltage balance, a closed-loop dq current control method is employed alongside DC-link voltage control. The performance of the proposed seventeen-level MLI is evaluated through MATLAB/Simulink simulations in a grid-tied PV system. Simulation results depicted that the total harmonic distortion (THD) in the grid current remains below 5%, meeting IEEE standards for power quality.

User Need Based Charging Strategies for Electric Vehicle

*Suraj S (BITS Pilani K K Birla Goa Campus)**

Abstract: Electric vehicle (EV) users require a flexible charging strategy that adapts to their needs. In routine scenarios, users can opt for normal charging, which enhances battery longevity and efficiency by delivering power at a controlled rate. However, in emergencies or time-sensitive situations, users can select fast charging to quickly replenish the battery and resume their journey with minimal delay. In case of vacation mode, users can provide their EV need of use time and date so that the charging system will delay the charging accordingly to avoid the calendar aging due to idle time of EV with high State of Charge. To demonstrate the effectiveness of this strategy, a MATLAB simulation has been developed to model both normal, fast and delayed charging modes for a 320V, 94.5 Ah Tata Nexon Indian EV Car.

Resonance Stability Analysis of Hydropower Plant Using Modified RH Criteria in Consideration of Sub-Synchronous Oscillation

Vijay Mohale (IIT Roorkee); Sunny Sonandkar (IIT Roorkee); Thanga Raj Chelliah (IIT Roorkee); Yogesh V Hote (IIT Roorkee)*

Abstract: Hydropower is an important source of renewable energy, providing reliable and flexible electricity generation. To improve power transmission efficiency, series compensation is commonly used to increase power transfer capacity. However, this method can also cause sub-synchronous oscillations (SSOs), which may affect the stability of the system. This paper aims to investigate the resonance stability of hydropower systems and provide a modified criterion for assessing their stability in consideration of sub-synchronous oscillations. The research focuses on the application of series compensation to increase power transfer capabilities with impact on the stability of hydropower systems under various operating circumstances. The paper first presents a brief overview of hydropower systems and their importance in the renewable energy sector. To check the impact of series compensation to investigate resonance stability though time domain simulation MATLAB/Simulink environment study. It then discusses the concept of resonance stability and the factors that can affect it, such as sub-synchronous oscillations. The RH stability criterion are then introduced as analysis tools for assessing the stability of hydropower systems.

SPECIAL SESSION 7:

Advances in Wired and Wireless Charging Infrastructure for Sustainable Vehicular Technologies

Enhanced Electric Vehicle Charging using a GaN-HEMT-based Buck Converter with a Resonant Gate Driver for Closed-Loop Operation

Vikram Saxena (NIT Manipur); Kundan Kumar (NIT Jamshedpur)*

Abstract: This paper explores a resonant gate driver circuit (RGDC) with closed-loop control for Gallium Nitride (GaN) high-electron-mobility transistors (HEMTs) in buck power conversion systems for electric vehicle (EV). Modern industries increasingly rely on high-frequency electronic devices, particularly Wide Bandgap (WBG) semiconductors like Silicon Carbide (SiC) and Gallium Nitride (GaN), for their superior characteristics over conventional silicon. The RGDC design aims to minimize gate power loss during high-frequency operation, enhancing overall performance. Simulations validate the effectiveness of the approach, showcasing improved voltage stability, reduced overshoot, and enhanced regulation compared to open-loop control. The closed-loop scheme dynamically adjusts and maintains desired output levels, leading to enhanced performance, stability, and reliability in GaN HEMT-based converters.

Reliability Assessment of High Gain Coupled Inductor based Boost Converter for Fuel Cell Electric Vehicle using Markov Analysis

Kumari Archana (NIT Jamshedpur); Simanta Kumar Samal (National Institute of Technology Jamshedpur); Abhishek Kumar (National Institute of Technology Jamshedpur); Madhu Singh (National Institute of Technology Jamshedpur)*

Abstract: Fuel Cell Electric Vehicles (FCEVs) offer a sustainable solution to modern transportation challenges, necessitating highly reliable components for optimal performance. The coupled Inductor-Based Boost Converter (CIBC) is essential in elevating voltage levels between the fuel cell stack and the DC link. The reliability of the CIBC is impacted by operational conditions, component ageing, and environmental factors, all of which influence system performance and lifespan. This study conducts a reliability assessment of crucial CIBC components by examining failure modes and reliability metrics, pinpointing significant factors affecting the converter's reliability. It also suggests strategies to enhance operational resilience. These findings aim to reduce downtime and improve the overall reliability of power systems in FCEVs, thereby fostering their broader adoption in sustainable transportation.'

A Universal Battery Charger with Wide Operating Voltage Range and Active Power Decoupling for Electric Transportation

Marrapu Sai Harsha Naidu (National Institute Of Technology Tiruchirappalli); Josephine R L (National Institute of Technology Tiruchirappalli)*

Abstract: Onboard electric vehicle (EV) chargers face limitations in charging speed, size, weight, and automotive compliance standards, resulting in extended recharge times. To address these constraints, chargers capable of accommodating a wide range of EV battery voltage levels play a crucial role. This paper proposes a wide-voltage-range battery charger with an output range of 120V to 900V, designed to charge existing and future battery packs from conventional single-phase AC supplies (85V to 265V). The proposed charger's buck-boost capability eliminates the need for a high-input filter on the grid side. Additionally, an active power decoupling method is implemented to remove the high-voltage DC link capacitor, thereby reducing space requirements and enhancing DC link voltage quality. A voltage doubler circuit in the charger's back-end minimizes the voltage transformation load on the DC-DC converter. To achieve these objectives, three streamlined control algorithms are employed. The viability of the proposed charger across all practical EV voltage ranges from 120V to 900V is demonstrated through both simulation and experimental results, utilizing a 3.3 kW wide-bandgap-based laboratory prototype.

Dynamic Performance Analysis of PMSM Motors Using Fuzzy Logic PID Controller

Naorem Rudra (NIT, Manipur); Sorokhaibam Nilkanta Meitei (NIT Nabipur); Vikram Kumar Saxena (NIT Manipur)*

Abstract: Permanent magnet synchronous motors (PMSMs) are widely adopted in various applications due to their high power density and efficiency. However, achieving optimal performance from PMSM drives necessitates robust and adaptable control strategies. Although commonly employed, traditional proportionalintegral-derivative (PID) controllers frequently have trouble managing the uncertainties and nonlinearities present in PMSM systems. To achieve better PMSM drive speed and torque control, this paper suggests the employment of fuzzy logic control (FLC) as an alternative. Due to its natural capacity to manage uncertainties and nonlinearities, FLC has the ability to enhance the robustness and dynamic behavior of PMSM drives.

In-Motion Charging Coil configuration for the Improved Battery Charging of Electric Vehicles

Kantipudi V V S R Chowdary (Kalinga Institute Of Industrial Technology Deemed To Be University); Kundan Kumar (NIT Jamshedpur); Subrata Banerjee (NIT Durgapur); Rajaram Kumar (GKCIET Malda); Vima Mali (Pandit Deendayal Energy University); Sanjeet Dwivedi (Siemens Gamesa Renewable Energy A/S)*

Abstract: The rapid development of electric vehicles (EVs) has highlighted the need for more efficient and convenient charging solutions. In-motion charging coil configurations present a promising advancement, allowing continuous wireless power transfer to EVs as they move, thus reducing downtime and improving overall battery performance. Dynamic wireless charging (DWC) systems, which enable In-Motion Charging Systems (IMCS), are posing prolific and profound impact on the charging of the Electric Vehicles (EVs). This paper presents a comprehensive analysis of coil configurations for in-motion electric vehicle (EV) charging, focusing on geometric optimization through the evaluation of mutual inductance and power transfer efficiency. A critical examination of in-motion charging coil design is conducted to ensure operation across a wide range of conditions while maximizing efficiency. Numerical simulations demonstrate that by fine-tuning key parameters, the magnetic coupler's performance can be optimized to meet specific operating requirements. The results indicate a substantial improvement in coil-to-coil power transfer efficiency, reaching up to 94%, even with significant variations in battery equivalent resistance (Rbeq) from 13% to 92%.

Analysis of Coupled Inductor based Full Bridge Dual Active Bridge Isolated Converter for Electric Vehicle Charging

Amit Irungbam (NIT Manipur); Kundan Kumar (NIT Jamshedpur); Benjamin Shimray (NIT Manipur)*

Abstract: A Coupled Inductor based Full Bridge Dual Active Bridge (CIFBDAB) isolated converter is proposed in this article. The proposed model is an integration of a buck-boost bidirectional DC-DC converter as the primary configuration and an H-bridge configuration on the secondary side where the isolation and transfer of power on both side is performed using a coupled inductor. The use of coupled inductor gives an advantage of reduced components counts of the proposed model. The phase shift of the gate pulse is monitored to regulate the flow of power. The proposed model is then compared with the conventional Dual Active Bridge (DAB) to identify the advantages of the proposed model. Lastly, the simulation of the proposed model is performed using the MATLAB 2024a to give the detailed performance analysis.

Analysis of SiC MOSFET-based Phase-shift and Quasi Square Wave Modulated Dual Active Bridge Converter for On-board Charging Application

Arnab Samanta (Ramkrishna Mahato Government Engineering College, Purulia); Sohom Ghosh (Ramkrishna Mahato Government Engineering College, Purulia); Olive Ray (Indian Institute of

Technology Bhubaneswar); Dipankar Chatterjee (Government College of Engineering and Textile Technology, Serampore); Sourav Tola (Ramkrishna Mahato Government Engineering College, Purulia)*

Abstract: The dual active bridge (DAB) converter is a bidirectional dc-dc converter having wide range of applications such as in renewable energy systems, electric vehicles (EV), dc microgrids, etc. This paper presents a SiC MOSFET-based phase shifted and quasi-square-wave modulated (PSQSWM) DAB converter for on-board charging application. There is more flexibility in controlling the active power flow in the converter by introducing a phase shift between the carriers of the two bridges as well as changing the width of the switch gate-pulses in one of two bridges. The different modes of operation have been discussed and MATLAB-Simulink digital simulation platform has been used verifying the proposed control of the DAB converter.

Digital Control System Based Isolated Totem Pole Converter for Electric Vehicle Onboard Chargers

Ajay Kumar Das (National Institute of Technology Karnataka, Surathkal); Ravi Raushan (National Institute of Technology, Surathkal)*

Abstract: A modified digital control method for totem-pole converters functioning in discontinuous conduction mode is proposed in this research. A hybrid approach combining an innovative digital control system with pre existing control techniques is used. Across a broad range of tasks, the suggested hybrid control provides a uniform efficiency graph. The suggested approach synchronization timing technique reduces current spike. The suggested hybrid modulation employs a smaller switching frequency band. A special half-square waveform figure with a frequency synchronized with the grid frequency 50Hz is used by the suggested digital control system. As a result, two output diodes function during half of the phase period decreases reverse recovery losses and zero current turn-on for the output diodes are obtained. The suggested hybrid control strategy performs better, as shown by the experimental data.

Analysis of Four-switch Non-isolated Non-inverting Buck-Boost Converter Considering Non-idealities

Prabin Petal (Ramkrishna Mahato Government Engineering College, Purulia); Unnayan Das Choudhury (Ramkrishna Mahato Government Engineering College, Purulia); Olive Ray (Indian Institute of Technology Bhubaneswar); Dipankar Chatterjee (Government College of Engineering and Textile Technology, Serampore)*

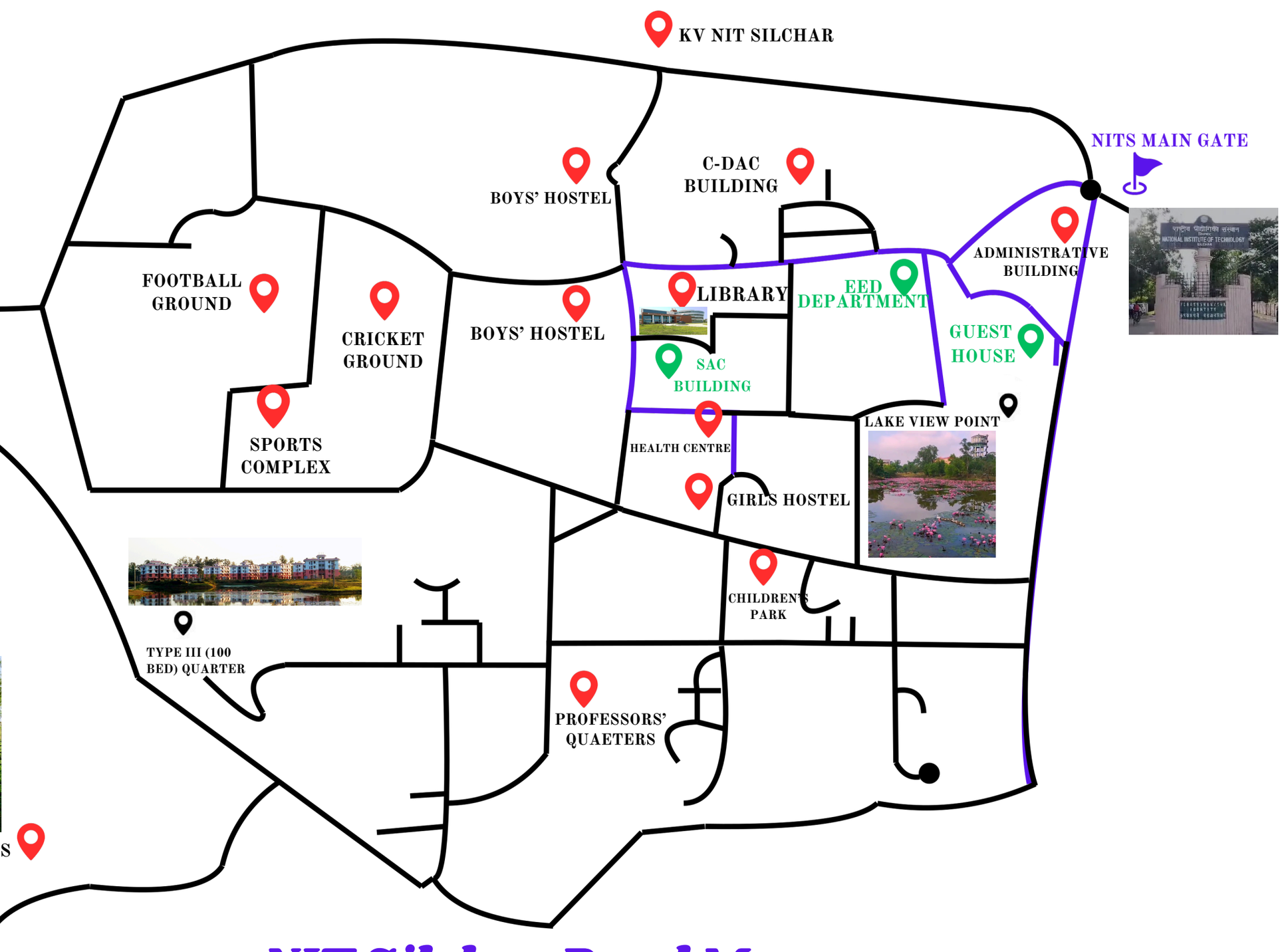
Abstract: Non-inverting Buck-boost converters have a wide application range such as in fuel-cells, battery-fed power supplies, telecommunication systems, electric vehicle charging infrastructure, etc. This paper presents an analysis of the four switch non-isolated non-inverting buck-boost converter considering the effect of non-idealities. Here, the main focus is to analyze the gain and inductor current ripple of the converter considering the resistance of the switches, when the duty ratios of the switches are controlled. MATLAB-Simulink digital simulation platform has been used verifying the analysis of the converter.

IEEE North East India International Energy Conversion Conference and Exhibition

NE-IECCE 2025

4-6 July 2025 | NIT Silchar, Assam, India

IEEE
Advancing Technology for Humanity



NIT Silchar Road Map

Technical Co Sponsors

Financial Co Sponsors

Co Sponsors

IEEE NE-IECCE 2025

NE IECCE
2025

IEEE

NE-IECCE 2025

Venue : National Institute of Technology Silchar