Report

On

ATAL Sponsored FDP

"Role of AI in Modern Power System Protection"

16th to 21st OCT 2023

Electrical Engineering Department

L D College of Engineering

Ahmedabad

Petron: Dr. C S Sanghavi

Convener: Dr. Ketan Badgujar

Coordinator: Dr V R Patel

Co-coordinator Dr. Z B Parekh

Team Members:

Prof S N Shivani

Prof R J Patel

Prof F A Macwan

Inauguration:

Date: 16th October 2023

Venue: Chanakya Hall, Electrical Engineering Department, L.D. College of Engineering, Ahmedabad

The Faculty Development Program on "Role of AI in Modern Power System Protection" was inaugurated on 16th October 2023 at Chanakya Hall, hosted by the Electrical Engineering Department at L.D. College of Engineering, Ahmedabad. This program was organized to enhance the knowledge and skills of the faculty and postgraduate scholars in the field of power system protection and artificial intelligence.

Participants: A total of 42 participants, including faculty members and postgraduate scholars, attended the inauguration ceremony.

Dignitaries:

Mr. Snehal Mehta- Executive Engineer, UGVCL

Major (Dr.) C. S. Sanghvi- Principal, LDCE

Prof. (Dr.) Ketan Badgujar- Head of the Electrical Department, LDCE

Dr. V. R. Patel- FDP Coordinator

The ceremony commenced with the lighting of the traditional lamp, symbolizing the dispelling of darkness and the acquisition of knowledge. The dignitaries were welcomed with floral bouquets, signifying the warmth of the institution's hospitality.

Speeches:

Mr. Snehal Mehta extended his appreciation for the initiative, highlighting the importance of AI in modern power systems. He stressed the significance of collaboration between academic institutions and power distribution companies for the betterment of society.

Major (Dr.) C. S. Sanghvi, the Principal of LDCE, emphasized the role of faculty development programs in fostering innovation and growth. He encouraged participants to make the most of the program and stay updated with the latest developments in the field.

Prof. (Dr.) Ketan Badgujar, the Head of the Electrical Department, LDCE, shared insights into the program's curriculum and objectives. He reiterated the department's commitment to fostering excellence in the domain of electrical engineering and power system protection.

Dr. V. R. Patel, the FDP Coordinator, provided an overview of the program's structure and schedules. He expressed his gratitude to the dignitaries and participants for their involvement and support.

The dignitaries' speeches were informative and inspiring, setting the tone for the upcoming faculty development program. The program's agenda, including workshops, lectures, and practical sessions, was outlined, ensuring that all participants were aware of the upcoming activities.

The inauguration ceremony concluded with a vote of thanks to all the dignitaries, participants, and organizers. It was followed by a networking session that allowed the attendees to interact and share their expectations from the program.

The Faculty Development Program on "Role of AI in Modern Power System Protection" promises to be a valuable platform for the exchange of knowledge and the enhancement of skills in the field of power system protection. We anticipate a successful and enriching experience for all participants in the days ahead.

Day 1:

The first day of the Faculty Development Program on "Role of AI in Modern Power System Protection" commenced with great enthusiasm and a thirst for knowledge. The highlight of the day was the inaugural lecture delivered by **Prof. (Dr.) Chirag Thakar**, the Head of the Computer Department at LDCE, on the topic of "Basics of AI and Cyber Security."

In his engaging and informative presentation, Dr. Thakar shed light on the fundamental concepts of Artificial Intelligence (AI) and its intersection with the critical realm of cyber security. He emphasized the importance of understanding the core principles of AI, including machine learning, neural networks, and data analysis, as they relate to modern power system protection. Furthermore, he stressed the need for a robust cybersecurity framework to safeguard AI applications in power systems.

The lecture was well-received by the participants, who found it to be an excellent introduction to the intricate world of AI and its implications in power system protection. Dr. Thakar's insights and expertise set the tone for the subsequent sessions and ignited a sense of curiosity among the attendees, propelling them towards a deeper understanding of the subject matter.

The first day of the Faculty Development Program on "Role of AI in Modern Power System Protection" continued to be both enlightening and engaging, with the second lecture featuring **Dr. Vipul Rajput**, an accomplished entrepreneur, who shared his expertise on "Optimal Relay Coordination using Optimization Toolbox."

Dr. Rajput's session delved into the practical application of optimization techniques in the context of relay coordination, a critical aspect of power system protection. He expounded on the use of optimization tools and methods to achieve the optimal settings for relays, thereby enhancing the reliability and efficiency of power systems. His real-world examples and insights into this intricate topic resonated with the participants, who appreciated the pragmatic approach to power system protection.

The lecture provided a bridge between theory and practice, allowing the participants to grasp the significance of integrating AI and optimization methodologies in modern power systems. Dr. Rajput's entrepreneurial perspective added a unique dimension to the day's learning, inspiring participants to consider innovative solutions to the challenges they might encounter in their academic and professional journeys.

The first day of the Faculty Development Program on "Role of AI in Modern Power System Protection" concluded with an enlightening practical session along with article discussion led by **Assistant Professor Fedrik Macwan**. The session, which focused on "Quantum Computing Basics," proved to be a captivating and intellectually stimulating way to wrap up the day's activities.

Professor Macwan's expertise in the field of quantum computing was evident as he introduced participants to the fundamental concepts and principles of this cutting-edge technology. With clear explanations and hands-on examples, he demystified the complex world of quantum computing, demonstrating its potential applications in power system protection.

Participants were particularly enthusiastic about this session, as it provided a glimpse into the future of computing and its potential to revolutionize the power system protection landscape. Quantum computing's ability to solve complex problems with unprecedented speed and efficiency left the attendees inspired and eager to explore its integration with AI in their academic and professional endeavors.

The practical session not only broadened the participants' horizons but also underscored the FDP's commitment to providing a comprehensive understanding of emerging technologies in the field. As Day 1 concluded on such a high note, it set a promising tone for the remaining days of the program, where more cutting-edge insights and knowledge await.

The success of Day 1 reaffirms the program's commitment to providing comprehensive knowledge and a holistic understanding of AI in power system protection, leaving the participants eagerly anticipating the wealth of knowledge yet to be explored in the coming days.

Day 2:

The second day of the Faculty Development Program on "Role of AI in Modern Power System Protection" brought a valuable addition to the participants' knowledge base with a session on "An Application of Dynamic Phasor in Power System Protection." This enlightening lecture

was presented by the distinguished **Prof. (Dr.) M.C. Chudasma**, a Experienced Professor in the Electrical Engineering Department at L.D. College of Engineering, Ahmedabad.

Dr. Chudasma's lecture was a deep dive into the application of dynamic phasor technology, a critical component of power system protection. Participants were captivated by his profound insights into the utilization of dynamic phasors to monitor, analyze, and control complex power systems. His presentation encompassed practical examples, case studies, and real-world applications, which illuminated the role of dynamic phasor technology in ensuring the reliability and stability of modern power grids.

Dr. Chudasma's expertise in the field was evident, and his presentation left the participants not only well-informed but also inspired to explore the potential applications of dynamic phasors in their research and practical work.

The second session of Day 2 of the Faculty Development Program on "Role of AI in Modern Power System Protection" featured a compelling presentation on "Random Forest: A Tool for Identification of Fault in Smart Grid Environment." The session was expertly delivered by **Prof. (Dr.) K. A. Bhatt**, an esteemed Assistant Professor in the Electrical Engineering Department at L.D. College of Engineering, Ahmedabad.

Dr. Bhatt's presentation offered a comprehensive exploration of the application of the Random Forest algorithm as a powerful tool in identifying faults within the smart grid environment. He detailed the algorithm's underlying principles, its advantages, and real-world applications, emphasizing its effectiveness in enhancing the reliability and efficiency of smart grids. The practical nature of the session was appreciated by the participants, as it provided insights into the application of AI techniques in real-time fault detection.

Participants found the session to be both informative and thought-provoking, leaving them with a deeper understanding of the role AI and machine learning play in the context of smart grids. Dr. Bhatt's expertise and ability to simplify complex concepts enriched the learning experience.

The concluding session of Day 2 of the Faculty Development Program on "Role of AI in Modern Power System Protection" provided a hands-on and enriching experience along with article discussion for all participants. This session featured a hardware demonstration of an AI-based differential relay and was conducted by **Prof. (Dr.) K. A. Bhatt**, an esteemed Assistant Professor in the Electrical Engineering Department at L.D. College of Engineering, Ahmedabad.

The hardware demonstration showcased the practical application of artificial intelligence in the field of power system protection, specifically in the context of differential relays. Participants had the opportunity to witness the real-time operation of an AI-based differential relay system, understanding how it detects faults and protects power systems from potential damage.

Prof. Bhatt's expertise and interactive approach made the session engaging and informative. Participants were able to see how AI algorithms are integrated into the hardware, enabling rapid decision-making in critical situations. This live demonstration left the attendees with a profound understanding of the potential impact of AI in enhancing the reliability and efficiency of power systems.

The session was a resounding success, bridging the gap between theory and practice, and reaffirmed the program's commitment to providing comprehensive knowledge and hands-on experience. As Day 2 came to a close, participants left the session with a tangible and exciting glimpse of the future of power system protection through AI.

Day 3:

Day 3 of the Faculty Development Program on "Role of AI in Modern Power System Protection" commenced with an insightful session on the topic "Challenges in Busbar Protection in Smart Grid Environment." This informative presentation was delivered by Prof. (Dr.) N.G. Choithani, an esteemed Assistant Professor in the Electrical Engineering Department at Pandit Deendayal Petroleum University (PDPU).

Dr. Choithani's session shed light on the complexities and intricacies of busbar protection within the dynamic landscape of a smart grid environment. He eloquently outlined the challenges that arise when safeguarding these critical components of power systems and

provided valuable insights into potential solutions. Participants gained a deep understanding of the evolving demands of smart grids and the need for advanced protection strategies.

The session encouraged participants to think critically about the intersection of busbar protection and the smart grid, as it is crucial for ensuring the uninterrupted supply of power. Dr. Choithani's expertise in the subject matter and engaging presentation style captivated the audience, leaving them with a renewed awareness of the ever-evolving field of power system protection.

As Day 3 began with this intellectually stimulating session, participants eagerly anticipated further discussions and learning opportunities on the horizon.

The second session on Day 3 of the Faculty Development Program, titled "Challenges with AI-based Protection," featured an enlightening presentation by **Prof. Bhavesh Bhalja**, a distinguished Professor from the prestigious Indian Institute of Technology (IIT) Roorkee. The session delved into the complexities and potential hurdles that can arise when implementing AI-based protection strategies in power systems.

Prof. Bhalja's presentation provided valuable insights into the challenges and nuances of incorporating artificial intelligence into power system protection. He discussed issues related to data quality, training algorithms, and system reliability, which are critical aspects to consider when applying AI in protection schemes. Participants were not only made aware of the potential pitfalls but were also equipped with strategies and best practices to address them.

The session fostered a deeper understanding of the intricacies of AI-based protection, and Prof. Bhalja's expertise shone through in his ability to articulate the challenges and offer solutions. The participants left the session with a more comprehensive view of the road ahead, as they navigate the integration of AI into power system protection.

As Day 3 progressed, the program continued to provide a well-rounded perspective on AI in power system protection, reinforcing its commitment to comprehensive learning and knowledge sharing.

The concluding session of Day 3 of the Faculty Development Program brought a practical and hands-on experience that left an indelible impact on the participants. This session consisted of a visit to the Switchgear and Protection laboratory along with article discussion, meticulously organized by **Prof. S. N. Shivani**, an esteemed Assistant Professor in the Electrical Engineering Department at L.D. College of Engineering, Ahmedabad.

The lab visit provided participants with a unique opportunity to explore and interact with various switchgear and protection equipment, gaining practical insights into the principles and operation of these critical components of power systems. Participants had the chance to witness the actual working of relays and other protective devices. This hands-on experience added a tangible dimension to their theoretical knowledge.

Prof. Shivani's guidance and expertise ensured that participants were able to appreciate the importance of practical training in power system protection. The lab visit not only deepened their understanding but also inspired a sense of curiosity and a stronger commitment to ensuring power system reliability and stability.

As Day 3 concluded with this immersive and interactive session, participants left with a greater appreciation for the practical aspects of power system protection, enhancing the overall learning experience.

Day 4:

Day 4 of the Faculty Development Program on "Role of AI in Modern Power System Protection" commenced with a thought-provoking session on the challenges in AC/DC microgrid protection. The session was presented by **Prof. (Dr.) Bhargav Vyas**, an esteemed Associate Professor from L.E. College, Morbi, with expertise in the field of Electrical Engineering.

Dr. Vyas's presentation focused on the complexities and intricacies surrounding the protection of AC/DC microgrids, a subject that is of growing importance in the context of modern power

systems. He eloquently outlined the unique challenges that arise in protecting microgrids, such as bidirectional power flow, the integration of renewable energy sources, and the need for adaptive protection schemes.

The session encouraged participants to delve deeper into the evolving landscape of microgrid protection, highlighting the significance of staying up-to-date with the latest developments and innovations in this area. Dr. Vyas's expertise and engaging presentation style made the subject matter accessible and thought-provoking.

As Day 4 began with this informative session, participants left with a broader understanding of the challenges that come with the integration of microgrids into the power system, paving the way for more informed and proactive approaches to protection.

Day 4 of the Faculty Development Program saw an enlightening session on the topic of "Digital Transmission Line Protection." The session was presented by the esteemed **Prof. J.R. Iyer**, a Professor from the Electrical Engineering Department at L.D. College of Engineering, Ahmedabad, and a renowned expert in the field.

Prof. Iyer's presentation was a deep dive into the world of digital transmission line protection, a critical aspect of ensuring the reliability and stability of power systems. He highlighted the evolving technologies and methodologies used in the protection of transmission lines, emphasizing the transition from traditional analog systems to digital solutions. The participants were given an in-depth understanding of the advantages and challenges of digital transmission line protection.

The session left participants not only informed but also inspired to explore the possibilities of digital protection in power systems. Prof. Iyer's expertise and his ability to demystify complex concepts enriched the learning experience.

As Day 4 continued to provide valuable insights and knowledge-sharing, participants left the session with a deeper appreciation for the role of digital technology in safeguarding transmission lines in the ever-evolving power system landscape.

The final session of Day 4 of the Faculty Development Program was a culmination of the week's insightful discussions and learning experiences. The session, along with article discussion ,titled "AI-Based Fuzzy Logic Control Implementation in MATLAB for Motor and Power System Protection" was conducted by **Mr. Mahammad Soaib Saiyad**, an accomplished Assistant Professor from CHARUSAT.

During this one-hour session, participants were introduced to the practical implementation of AI-based fuzzy logic control for motor and power system protection using MATLAB. Mr. Saiyad's expertise and hands-on approach allowed participants to witness the integration of AI and fuzzy logic in real-time applications. The session not only provided a comprehensive understanding of the technology but also inspired attendees to consider its potential applications in their academic and professional work.

The practical demonstration in MATLAB enabled participants to gain practical experience in creating control systems and protecting motors and power systems using AI and fuzzy logic. This hands-on experience left the participants with a deeper appreciation for the fusion of technology and protection strategies.

As the FDP continued to provide a holistic learning experience, this final session capped off Day 4 with an exciting and practical glimpse into the future of motor and power system protection through AI.

Day 5:

The fifth day of the Faculty Development Program began with a highly anticipated session on "AI-Based Conditional Monitoring and Protection of Transformers." This enlightening presentation was delivered by none other than **Prof. (Dr.) K.P. Badgujar**, the Professor and Head of the Electrical Engineering Department at L.D. College of Engineering, Ahmedabad.

Dr. Badgujar's presentation provided a comprehensive overview of the application of artificial intelligence in the conditional monitoring and protection of transformers, a critical component of power systems. He emphasized the importance of predictive maintenance and early fault

detection, showcasing how AI techniques can enhance the reliability and longevity of transformers.

Participants were not only informed about the theoretical aspects of AI-based protection but were also exposed to practical examples and case studies. Dr. Badgujar's extensive knowledge and experience in the field shone through, enriching the learning experience for all attendees.

As Day 5 began with this enlightening session, participants left with a profound appreciation for the role of AI in ensuring the efficient operation of transformers, further solidifying their commitment to the world of modern power system protection.

The Industrial Visit session of the Faculty Development Program brought an enriching and hands-on experience for all participants. This final session involved a visit to the Power System Protection laboratory at PDEU (Pandit Deendayal Energy University) in Gandhinagar. The visit was meticulously organized, and during this visit, the participants had the privilege of being guided by **Dr. Pawal Venkta**, a faculty member, and **Mr. Jitendra Prajapati**, the lab assistant.

Participants were given a comprehensive tour of the lab, where they had the opportunity to interact with various panels and experimental setups related to power system protection. Dr. Pawal Venkta and Mr. Jitendra Prajapati provided detailed explanations of the experiments, equipment, and their applications in power system protection. Participants could witness firsthand the practical aspects of the theories they had learned during the FDP.

The visit was not only informative but also inspiring, as it highlighted the significance of practical training and hands-on experience in the field of power system protection. It provided participants with a deeper understanding of how the theoretical concepts are applied in real-world scenarios.

Day 6:

The final day of the Faculty Development Program commenced with a thought-provoking and insightful session titled "An Application of Artificial Intelligence in Power System Protection." The session was led by the distinguished **Prof. (Dr.) B.N. Suthar**, who serves as both a Professor and the Principal of L.E. College, Morbi.

Dr. Suthar's presentation provided a comprehensive exploration of the practical application of artificial intelligence (AI) in the field of power system protection. With expertise and authority, he highlighted the role of AI in enhancing the reliability and efficiency of power systems. He offered insights into real-world applications, case studies, and the transformative potential of AI in power system protection.

Participants were not only informed about the possibilities but were also inspired to explore innovative solutions and AI-driven strategies in their academic and professional work. Dr. Suthar's vast knowledge and engaging presentation style left an indelible impact on the participants, instilling a deep appreciation for the significance of AI in modern power systems.

As the final day began with this enlightening session, participants left with a profound understanding of the power of AI in the realm of power system protection, capping off a week of invaluable learning experiences.

As part of the Faculty Development Program (FDP) on "Role of AI in Modern Power System Protection," participants were encouraged to prepare reflection journals to document their thoughts, insights, and takeaways from the various sessions conducted during the program. Additionally, a Multiple Choice Question (MCQ) test was administered to evaluate the participants' understanding of the FDP content, followed by soliciting feedback about the program. Here's a summary of the process and results:

Reflection Journals**:** Participants were asked to maintain reflection journals throughout the FDP to record their reflections and notes on each session. These journals served as a means for participants to consolidate their learning, jot down queries, and express personal insights. The journals were highly beneficial in helping participants internalize the content and apply it to their respective roles and interests. They provided a medium for self-assessment and self-directed learning.

MCQ Test: To assess the participants' comprehension of the FDP content, a Multiple Choice Question (MCQ) test was conducted, covering key topics from the program's sessions. The test

aimed to gauge how well participants absorbed and retained the material presented to them during the program. The test was a valuable tool to evaluate knowledge transfer and retention.

Feedback: After the MCQ test, participants were encouraged to provide feedback on the FDP. The feedback solicitation was a vital component in understanding the overall effectiveness of the program. Participants were invited to share their thoughts on session content, instructors' presentations, the structure of the program, and the organization. Their feedback was essential for refining future FDPs and tailoring them to the needs of the participants.

Overall, the reflection journals, MCQ test, and feedback collection were integral elements in ensuring the success of the Faculty Development Program. The journals helped participants retain knowledge, the MCQ test evaluated their understanding, and the feedback facilitated continuous improvement. This comprehensive approach ensures that future FDPs will be even more tailored to the participants' needs and will continue to be a valuable platform for learning and professional growth.

Valedictory Ceremony

Date: 21st October 2023

Venue: Chanakya Hall, Electrical Engineering Department, L.D. College of Engineering, Ahmedabad

The valedictory ceremony of the Faculty Development Program on "Role of AI in Modern Power System Protection" marked the culmination of an enlightening week of learning and knowledge-sharing. Held on the 21st of October 2023 in the prestigious Chanakya Hall at the Electrical Engineering Department, L.D. College of Engineering, Ahmedabad, the event was attended by a total of 42 faculty members and postgraduate scholar participants.

Dignitaries: The ceremony was graced by the presence of esteemed dignitaries:

Prashant Halari- Entrepreneur and Author

Major (Dr.) C. S. Sanghvi- Principal, LDCE

Prof. (Dr.) Ketan Badgujar- Head of the Electrical Department, LDCE

Dr. V. R. Patel- FDP Coordinator

The valedictory ceremony began with the lighting of the traditional lamp, symbolizing the dispelling of darkness and the pursuit of knowledge. It set the tone for an event that was both celebratory and reflective.

Speeches:

Prashant Halari commenced the proceedings with an insightful speech on the role of knowledge and innovation in the modern world. He emphasized the importance of continually expanding one's horizons, the fusion of academic theory with practical experience, and the invaluable role of educators in shaping the future.

Major (Dr.) C. S. Sanghvi, the Principal of LDCE, delivered an inspiring address, commending the participants for their dedication and thirst for knowledge. He underscored the critical role of faculty development in an institution's growth, academic excellence, and impact on society.

Prof. (Dr.) Ketan Badgujar expressed his appreciation for the commitment and active participation of the attendees throughout the FDP. He emphasized the significance of faculty

development in equipping educators to stay at the forefront of technological advancements and provide quality education.

Dr. V. R. Patel, the FDP Coordinator, highlighted the journey of the program and shared the achievements and successes. He encouraged the participants to apply the knowledge and insights gained during the FDP in their academic and professional roles.

Each dignitary's speech was a source of inspiration, providing attendees with valuable insights and a renewed commitment to their roles as educators and researchers in the field of power system protection.

Vote of Thanks: Dr. V. R. Patel, the FDP Coordinator, delivered the vote of thanks, expressing gratitude to the dignitaries, instructors, coordinators, and participants. He emphasized the collective effort that made the FDP a resounding success, concluding by encouraging all to continue their pursuit of knowledge and to apply what they've learned in their academic and professional journeys.

As the ceremony ended, participants left the venue with a sense of accomplishment and a commitment to further their contributions in the realm of power system protection. The Faculty Development Program on "Role of AI in Modern Power System Protection" was a fulfilling and enlightening experience, fostering growth and innovation in the field of power systems.