

*Post-event Report*

# **Workshop on Power Engineering: Curricula, Research, and Outreach**

*Organized by:*

**Department of Electrical Engineering, IIT Bombay**

**15.06.2019**

**VMCC, IIT Bombay**



## Technical Program

	Time Slot	Activity
Inaugural Session	09:30 – 09:35	Welcome Address - Prof. S. V. Kulkarni, IIT Bombay
	09:35 – 09:45	Address by Prof. B. G. Fernandes, Head, EE Department, IIT Bombay
	09:45 – 09:55	Address by Prof. S. Chaudhuri, Director, IIT Bombay
	09:55 – 10:05	Address by Chief Guest Mr. S. K. Soonee, Advisor POSOCO
	10:05 – 10:10	Felicitations of Prof. S. A. Khaparde, IIT Bombay
	10:10 – 10:15	Vote of Thanks by Prof. Abhijit Abhyankar, IIT Delhi
High Tea	10:15 – 10:45	
Keynote Talk	10:45 – 11:00	“Governance and Institutional Engineering Issues in a Very Large Power System” – Mr. S. K. Soonee, Advisor POSOCO
Utility Perspective and Challenges	11:00 – 11:15	“Emerging Trends and Thrust Areas in Indian System Operation” – Mr. Vivek Pandey, WRLDC
	11:15 – 11:30	“Power Point Engineer vs Power System Engineer – Utility Perspective” – Dr. K. Rajamani, Adani Electricity Ltd.
	11:30 – 11:45	“Mumbai Transmission Constraints and Intra-State ABT /DSM Mechanism” – Prafulla Varhade, Director (EE), MERC
	11:45 – 12:00	“TSO-DSO Coordination for Efficient Operation & Planning of Power Systems” – Prof. Abhijit Abhyankar, IIT Delhi
Curriculum, Collaborations, and Outreach	12:00 – 12:15	“Power Engineering Curriculum - A Perspective” – Prof. A. M. Kulkarni, IIT Bombay
	12:15 – 12:30	“Executing Projects for Utilities: Experience and Way Ahead” – Prof. S. A. Soman, IIT Bombay
	12:30 – 12:45	“Industry Sponsored Research” – Prof. Himanshu Bahirat, IIT Bombay
	12:45 – 13:00	“International Collaborations: Experience and Opportunities” – Prof. Anupama Kowli, IIT Bombay
	13:00 – 13:15	“Evolution of Indian Power System” – Prof. S. A. Khaparde, IIT Bombay
Lunch	13:15 PM – 14:00 PM	
Recent Developments and Emerging Trends	14:00 – 14:15	“Microgrid Protection: Major Challenges and Recent Developments” – Prof. Ashok Pradhan, IIT Kharagpur
	14:15 – 14:30	“Campus Energy Monitoring System” – Prof. Y. Pradeep, IIT Hyderabad
	14:30 – 14:45	“Droop Control in an AC Microgrid with High R/X Ratio” – Prof. Vaskar Sarkar, IIT Hyderabad
	14:45 – 15:00	“Challenges and Opportunities in Power Transmission and Distribution Sectors in India” – Mr. Chandresh Dobariya, Panacean Energy Solutions
Informal Session	15:00 – 15:30	Video Clips from Overseas Speakers and Spontaneous Contributions
Tea	15:30 – 16:00	

Program Co-ordinators: Prof. S. V. Kulkarni, IIT Bombay  
Prof. Abhijit Abhyankar, IIT Delhi  
Prof. Pradeep Yemula, IIT Hyderabad

## Inaugural Session

### **Welcome Address**

*Prof. S. V. Kulkarni, IIT Bombay*

Prof. Yemula Pradeep (IIT Hyderabad) welcomed all participants and requested the Chief Guest, Mr. S. K. Soonee, Advisor, POSOCO, Prof. Subhasis Chaudhuri, Director, IIT Bombay, Prof. B. G. Fernandes, Head, Department of Electrical Engineering Department, IIT Bombay, and Prof. S. A. Khaparde to occupy seats on the dais. In the welcome speech of the workshop, Prof. S. V. Kulkarni, IIT Bombay, spoke about the motivation behind organizing this workshop. Primarily, this workshop has been arranged to commemorate the illustrious career of Prof. S. A. Khaparde spanning almost four decades at IIT Bombay. His contributions to the Department and the Institute are well-known, and he has been a very adorable and revered person on the IIT Bombay campus. Prof. S. V. Kulkarni briefly outlined the technical program of the workshop. In addition to talks by Indian experts in Power Engineering area, who have interacted with Prof. Khaparde, presentations of his former students from various academic institutions, utilities and industries were also scheduled. He thanked participants for their overwhelming response to the workshop and urged them and students of IIT Bombay to participate actively in deliberations during the day.



### **Address by Head of the Department**

*Prof. B. G. Fernandes, IIT Bombay*

Subsequently, Prof. B. G. Fernandes, Head of the Department of Electrical Engineering, delivered his address and summarized contributions of Prof. Khaparde to the department and the power engineering fraternity. Prof. Fernandes said that post retirement of many power engineering faculty members in 1990s, Prof. Khaparde almost single-handedly developed and nurtured the power engineering group in the department. He gave a complete free-hand to new-joining faculty members at that time, which has been of immense help for re-establishment of a strong power group in the department. Prof. Fernandes gave a brief count of his remarkable publication record including books and numerous papers in IEEE Transactions, enviable citation index, details of overseas contributions as a visiting faculty in various universities, contributions to two flagship conferences in Power Systems, viz. National Power Systems Conference and International Conference on Power Systems, and active role in various committees and regulatory commissions at the state and central levels. His expertise is sought-after by the government, industry and academia. Prof. Khaparde has successfully

completed many research projects sponsored by not only Govt. funding agencies like DST, MHRD, and CPRI, but also industries such as IBM and Applied Materials. Prof. Fernandes concluded his address by enumerating important awards received by Prof. Khaparde.



#### **Felicitations of Prof. S. A. Khaparde**

After the speech by Prof. Fernandes, Prof. S. Chaudhuri, Director, Indian Institute of Technology Bombay, felicitated Prof. Khaparde with a shawl.



Subsequently, Mr. S. K. Soonee, Advisor POSOCO, felicitated Prof. Khaparde with a photo depicting a scene from Mahabharat, wherein Lord Krishna advises Shri Arjun through Bhagavad Gita. Mr. Prafulla Varhade, Director (EE), MERC, also felicitated Prof. Khaparde with a bouquet.



### **Address by Director**

*Prof. S. Chaudhuri, Director, IIT Bombay*

Next, Prof. S. Chaudhuri, Director IIT Bombay, said in his speech that Prof. Khaparde laid a strong foundation of the present Power Group at the Department, which in early 1990s had become weak due to retirement of many faculty members. Prof. Chaudhuri said that he has interacted with Prof. Khaparde closely for 30 years and he has seen him building a strong Power Group in the department. He said that Prof. Khaparde is a well-known leading researcher and an outstanding teacher/ mentor. The Director also told the gathering of professionals from various academic institutions, utilities and industries about outreach initiatives of IIT Bombay and urged them to take advantage of them. Prof. Chaudhuri also unfolded spirituality aspect of Prof. Khaparde's life and ended the speech indicating the benefit received from association with him.



### **Address by Chief Guest**

*Mr. S. K. Soonee, Advisor, POSOCO*

Next, Mr. S. K. Soonee delivered his speech to recount significant contributions of Prof. Khaparde to the Indian power system, which include seminal work on planning, power flow, pricing, and tracing. Prof. Khaparde was a member of committee of three academicians whose to-the-point, subtle and well-articulated recommendations have made long lasting and positive impact on power system operation and control of the Indian Power Sector. He has always been quick to sense initiatives by leading global institutions and researchers, and to start corresponding activities in India; one such example is Common Information Model. Finally, Mr. Soonee also thanked Prof. Khaparde for

motivating him to interact with academia through active participation in national conferences and workshops.



### **Recognition of Contributions**

Next, Mr. Vasant Pande, Supdt. Engineer (SCADA/Admin), MSLDC, MSETCL, enthusiastically acknowledged contributions of Prof. Khaparde to Maharashtra power system as a member of expert committees from time to time. He shared that Prof. Khaparde chaired a committee constituted by MERC to review intra-state ABT mechanism. He indicated that Deviation-Settlement Mechanism (DSM) recommended by Prof. Khaparde Committee will become operational by April 2020.



Mr. D. A. Sathe, an alumnus of IIT Bombay and former Director of Tata Power Company (TPC), narrated his close association with Prof. Khaparde. He said that TPC has many times approached IIT Bombay and Prof. Khaparde in particular for investigations of blackouts and other major issues. Recommendations of such committees helped the company to take corrective and preventive actions to strengthen the power network.

In his remarks in response to felicitation, Prof. Khaparde thanked everyone, who spoke on the occasion, and said that he tried best to do duties throughout his career at IIT Bombay. He also mentioned that IIT Bombay campus life is highly conducive to pursue professional and personal goals.





### **Vote of Thanks**

*Prof. A. R. Abhyankar, IIT Delhi*

Prof. Abhijit Abhyankar, IIT Delhi, presented the vote of thanks to speakers, attendees, and student volunteers for making the workshop successful.



### **Session 1: Keynote Talk**

#### **Governance and Institutional Engineering Issues in a Very Large Power System**

*Mr. S. K. Soonee, Advisor POSOCO*

During his talk, Mr. Soonee pointed out that governance and regulation are the key elements for restructuring of the power system. Because of different stakeholders, the governance of the power system can be challenging, and the regulators need to remain fair. He opined that reforms are essential to reduce social conflicts. He commented that participation of intellectuals and experts in debates during reform processes is unfortunately missing.

Elaborating the difference between governance and regulation, he set up the context of hard and soft side of the reforms. The hard side of the reform deals with the technical and economic issues of the engineering problem. To deal with the multitude of social and technical issues, in his discussion, he indicated the requirement of the multidisciplinary approach in the power system, underlining the

role of specialists. He further added that the soft side of the reform relies on the existence of an impartial sustainable institution, which can guide in the event of a conflict of interest.



## **Session 2: Utility Perspective and Challenges**

### **Emerging Trends and Thrust Areas in Indian System Operation**

*Mr. Vivek Pandey, WRLDC*

As the title symbolizes, in this talk, Mr. Pandey commented that the key thrust areas in the operation of Indian Power System are increasingly getting decided by growing requirement of renewable generating resources. He indicated that, along with renewable energy certificates, recent regulations of POSOCO aim to meet renewable energy targets. To alleviate variability of renewables, under the single frequency grid concept, transitioning to faster scheduling and metering (from 15 minutes to 5 minutes) is being pushed forward. Additionally, secondary frequency control and frequency control continuum are also looked into. Capacity building and ramping capability are also thrust areas for increased renewable energy penetration.





## **PowerPoint Engineer vs Power System Engineer – Utility Perspective**

*Dr. K. Rajamani, Adani Electricity Ltd.*

During his talk, Dr. Rajamani pointed out increasing reliance on software tools for power system analysis, resulting in a significant decline in logical reasoning abilities. He gave simple examples which can be easily worked out without resorting to software. Hand calculations based on sound fundamentals become useful to cross-check results of software simulations. He urged academic institutes, training schools, and industries to take this important issue into account while training manpower.



## **Mumbai Transmission Constraints and Intra-State ABT /DSM Mechanism**

*Mr. P. Varhade, Director (EE) MERC*

Mr. Varhade primarily focused on two of Prof. Khaparde Committee recommendations. In the post-2010 partial grid disturbance aftermath, transmission bottleneck inducing higher power purchase cost was identified as a major issue, and remedial transmission strengthening process was recommended. Additionally, a committee to foresee the transmission expansion plan was set up. Intra-State ABT/DSM Mechanism to enable a market structure within the state is already in the preparatory stage.



## TSO-DSO Coordination for Efficient Operation & Planning of Power Systems

*Prof. A. Abhyankar, IIT Delhi*

In contrast to the traditional power system operation, increasing penetration of voltage-dependent specific entities in the distribution network to which the conventional transmission network is usually blind, requires coordination among TSO and DSO. To solve this problem, Prof. Abhyankar suggested different market architecture and coordination models. He discussed three different coordination models: (i) centralized market, (ii) local market, and (iii) common TSO-DSO model, and explained these models through diagrammatic representations.



## Experiences from Field Research

*Prof. S. Chakravorti, Director, National Institute of Technology Calicut*

Prof. S. Chakravorti talked on multidisciplinary nature of today's high voltage engineering problems. He described how a simple problem of calculating capacitive current through a transformer bushing, if a voltage is applied, led one to deal with advanced signal processing techniques, because of measurement noise. He also explained challenges in accurate measurements involved in dielectric frequency spectroscopy of an insulating system.



### **Session 3: Curriculum, Collaborations, and Outreach**

#### **Power Engineering Curriculum – A Perspective**

*Prof. A. M. Kulkarni, IIT Bombay*

Prof. Kulkarni pointed out that a conventional approach of teaching power engineering courses has been “top-down”. It does not seem to be an effective approach and students do not get enthused by heavy “analysis” component. It is also not amenable for creating laboratory experiments to aid theory. He discussed an alternative way which is “bottom-up” that starts with more tangible topics like distribution systems. This alternative can include both analytical and hands-on components. He also pointed out the tendency to cram the curriculum with many topics and the way competitive exams influence the topics being covered in courses.



#### **Executing Projects for Utilities: Experience and Way Ahead**

*Prof. S. A. Soman, IIT Bombay*

Prof. Soman fondly recollected memories of his association with Prof. Khaparde and shared many photographs which captured their professional and personal relationships. He also mentioned about the experience of co-authoring a book with Prof. Khaparde. Prof. Soman then gave a brief outline about the synchrophasor analytics developed at PowerAnser Lab and emphasized the need for proper instrumentation. He underlined the importance of visualization tools for creating effective human-machine interfaces.



## Industry Sponsored Research

*Prof. Himanshu Bahirat, IIT Bombay*

Prof. Bahirat discussed how sponsored research can benefit academia and industry, in the context of a project he undertook on superconducting fault current limiters. He mentioned that while the industry gets access to a pool of talents, the academic entity benefits by learning about opportunities and challenges in practical world. He touched upon the importance and role of MoUs, NDAs, and IP policies in any collaborative research work.



## International Collaborations: Experience and Opportunities

*Prof. Anupama Kowli, IIT Bombay*

Prof. Anupama commented that a successful collaboration generally has well-defined objectives. She also pointed out that lack of clarity on objectives and responsibilities make the collaboration vulnerable. She observed that international collaborations are helpful in leveraging existing knowledge and technology, avoiding the need to “re-invent the wheel”. Prof. Anupama also emphasized the increasing need for interdisciplinary research which brings together data scientists, social scientists, economists, etc.





#### **Session 4: Evolution of Indian Power System**

*Prof. S. A. Khaparde, IIT Bombay and Prof. D. Thukaram, Former Faculty, IISc Bangalore*

Prof. Thukaram felicitated Prof. Khaparde and shared fond memories of personal and professional association with him. Prof. Thukaram elaborated on how the power system researchers at various IITs and IISc contributed to Indian power sector in the initial years. He further described how the system evolved over the years and the role played by academia in influencing planning and operational framework of the system.



In his talk, Prof. Khaparde commented that with the use of information and communication technologies, the Indian power system is steadily developing. He narrated how the system has evolved over the last four decades and mentioned that many challenges of today and future can be overcome by participation and contributions of interdisciplinary entities. In regard to spiritual interests, he said life is flowing and needs to be enjoyed always as fresh and new. He counted benefits of spiritual practices while contributing professionally.



## **Session 5: Recent Developments and Emerging Trends**

### **Microgrid Protection: Major Challenges and Recent Developments**

*Prof. A. K. Pradhan, IIT Kharagpur*

Prof. Pradhan began his talk by commenting that Prof. Khaparde has immensely influenced many people in a positive way. Subsequently, Prof. Pradhan spoke on the requirement of resiliency in microgrids. He indicated that active devices and bidirectional flow in the distribution network can lead to 'protection blinding'. He explained the concept of 'overrated converter' which ensures stability. For the microgrid protection, Prof. Pradhan pointed out inadequacies in traditional directional and distance relays for protection of future microgrids. He concluded his presentation indicating challenges in protection aspects of microgrids.



### **Campus Energy Monitoring System**

*Prof. Pradeep Yemula, IIT Hyderabad*

To start with, Prof. Pradeep expressed gratitude to Prof. Khaparde for mentoring during his PhD at IIT Bombay. Prof. Pradeep then enumerated details of the work he is carrying out at IIT Hyderabad campus. To bridge the gap between requirement of power system data analytics and unavailability of sufficient data, he is creating a database of the energy consumption information of Academic Block A Building of IIT Hyderabad, as a test case. The monitoring is made possible through a hardware based on Raspberry Pi SBC board. Encouraged by its success, now he is taking the project to the next level through campus level load-monitoring and he presented some important campus load characteristics. Prof. Pradeep wishes to take the current energy monitoring to the next level through a project "Multi-Campus Energy Monitoring System".





## **Droop Control in an AC Microgrid with a High R/X Ratio**

*Prof. Vaskar Sarkar, IIT Hyderabad*

Prof. Sarkar began presentation by highlighting benefits of his association with Prof. Khaparde during PhD. Subsequently, he presented one of his recent works on microgrid droop control. Following a load imbalance, accurate power-sharing among the generators becomes essential for a stable microgrid, and the power-sharing needs to become active only in the post imbalance condition. In this regard, his research group has developed a transiently coupled droop control methodology aiming to improve the system stability, while maintaining desired steady-state performance.



## **Challenges and Opportunities in Power Transmission and Distribution Sectors in India**

*Mr. Chandresh Dobariya, Panacean Energy Solutions*

In this talk, Mr. Dobariya mentioned about the involvement and support of Prof. Khaparde in establishment of the organization he founded. He then described business viewpoint of the operation of the Indian power industry. He spoke about challenges an entrepreneur faces in doing business in power sector. Unavailability of sufficient and correct data is a major issue in the pan-India electricity sector. Mr. Dobariya said that Panacean is actively working to solve some of the indicated challenges, and highlighted that many business opportunities exist in the Indian power market.



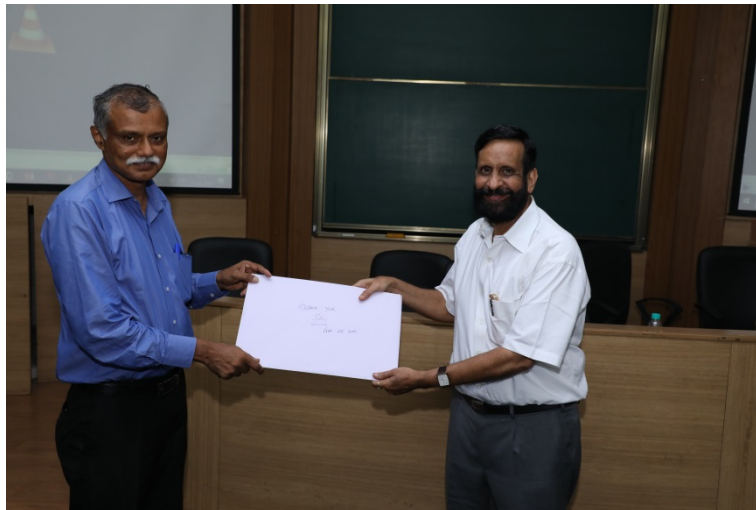
### Session 6: Informal Interactions

The following delegates who could not attend the workshop in-person sent their wishes via videos:

- (i) Prof. Sukumar Brahma, SCE&G Distinguished Professor of Electrical and Computer Engineering, Clemson University, USA
- (ii) Dr. Ashish Agalgaonkar, Senior Lecturer, School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, Australia
- (iii) Mr. Mital Kanabar, Chief Applications Architect - Grid Automation, GE Canada
- (iv) Mr. Vishal Pandya, Co-Founder & Director, REConnect Energy

They shared their current affiliation and research areas while also reminiscing their association with Prof. Khaparde.

Subsequently, Prof. B. G. Fernandes, Head of Electrical Engineering Department, IIT Bombay, presented Prof. Khaparde with a greeting card signed by attendees of the workshop and a memento (wall piece).



At the end, some of the attendees presented their testimonials recognizing the impact made by Prof. Khaparde in their personal and/or professional lives.

Prof. S. V. Kulkarni, EE Dept, IIT Bombay

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