

Sarvajanik College of Engineering and Technology, Surat

Report On

Two Week “Electric Power System” Main Workshop

Organized by IIT Kharagpur & IIT Bombay

Under

Train Ten Thousand Teachers (T10KT) project from the National Mission on

Education through ICT (NMEICT)

(MHRD, Govt. of India)

10-15th July 2017

Indian Institute of Technology, Kharagpur in association with *Indian Institute of Technology, Bombay* conducted a Two-Week ISTE MAIN WORKSHOP on “Electric Power System” from **10- 15th July 2017** under the National Mission on Education through ICT (NMEICT) at various Remote Centres. *Sarvajanik College of Engineering and Technology* was also one of the prominent remote centres of South Gujarat region. The objective of the workshop was to prepare the faculty of engineering colleges with the knowledge of Power System.

The lectures were transmitted live and received at more than 194 remote centres across the country, along with the interaction of participants. Participants assembled at the selected Remote Centers for 6 days face to face interaction and lecture sessions through A-VIEW After completing the online assignments spread over 4 to 5 weeks.

The workshop at the remote centre *Sarvajanik College of Engineering and Technology, Remote Center ID: 1043* was coordinated by the Remote Centre Coordinator **Prof. Hitesh k. Mehta (Associate Professor, EED)** and Workshop Coordinator **Prof. Naman B. Bhatt (Assistant Professor, EED)** in which 25 faculties from various technical institute of South Gujarat participated.

The workshop was inaugurated on **10th July 2017** at **9:00 a.m.** by **Prof. Raja Dutta (Principal Investigator, IIT Kharagpur)**,

Following distinguished guests were present during the inauguration.

- **Prof. Adrijit Gosawami** (Dean , Continuing Education, IIT Kharagpur)
- **Prof. P.K. Biswas** (HOD, Electrical and Electronics communication engineering department, IIT Kharagpur),
- **Prof. N.K. Kishore**(Course Coordinator, IIT Kharagpur)

They welcomed all the participants of various remote centres in which more than 4260 faculties were participated and emphasized on the importance of core subject like Power System and also shared the advantages of this workshop.

Day 1: 10th July 2017

At 09:30 AM the introduction session was conducted by **Prof. N. K. Kishore (IIT Kharagpur)**, **Prof. S. A. Soman (IIT Bombay)**, **Prof. Gautam Bandyopadhyay (IEST, Shibpur, Kolkata)**. They gave an overview of the course and also discussed the history of Electrical Engineering and Current trends.

Prof. Bandyopadhyay started the second session at 11:15 AM on ***“Power System Steady State Operation”***. He discussed about Power Quality, Power Quantity, Power System States, Transmission lines, compensation, and benefit of FACTS technology. He added Typical Power Flow Economic Despatch / Optimal and State Estimation etc. He also discussed Schedule Generator Powers and other controllable parameters so that some economic objective has met.

After Lunch third session was started at 1:45 pm in which **Prof. Soman** delivered a lecture on ***“Power flow analysis and power transfer capability”***. He signifies the study of Power flow and also made participant to learn the calculation of power flow with an example.

He discussed INDIAN POWER SYSTEM, he explained transmission line (66kV and above): Installed capacity: 330 GW and Peak Demand.

He ended the session at 3:15 pm by explaining Reliability Margins.

The fourth and the last session of the first day was presented again by, **Prof. Bandopadhyay** on ***“Symmetrical Faults”***. During this session, he discussed about the various faults in transmission lines and also explained the various methods to detect the line faults.

Day 2: 11th July 2017

First session of the second day was started at 9:30 AM by **Prof. Gautam Bandyopadhyay**. He discussed ***“symmetrical components”*** in which he explained the basic detail about the symmetrical components. He also explained unsymmetrical fault, phase shift of symmetrical components in star-transformer, phase shift of voltage phasor, calculation of power using symmetrical components, complex power in terms of phase. Taking numerical examples with reference of NPTEL lectures (IIT Kanpur) explained how voltage drops in the

transmission network, it is because of flow of unbalanced current. Conclusion to this was that symmetrical components of unbalanced current flowing in a balanced Star - load or in balanced series impedance. In end of the session he explained about the protection against unbalanced current, effect of unbalanced voltage at single phasing on induction motor and sequence reactance of system component.

Prof. S. A. Soman started the second session at 11:15 AM on ***“Transformer”***. He explained the basics of 3- ϕ transformers and discussed the different phasors for the star and delta connected transformer. He also discussed various faults occurs on the transformers. By deriving the equations he explained the zero sequence current and the effect of zero sequence current in the transformers. He also told that balanced 3rd harmonics in 3- ϕ also reflects as zero sequence.

The third session of the day was presented again by, **Prof. Bandopadhyay** at 1:45 PM on ***“Unsymmetrical Faults”***. During this session, he discussed about the various faults in transmission lines, He explained the various methods to detect the line faults, Faults on unloaded generator, line faults between different phases, line faults with two different phase short circuited and grounded. He also explained how an unsymmetrical fault can be calculated for loaded generator. At last he ended the lecture by explaining several numerical problems.

Prof. Gautam Bandyopadhyay delivered the lecture during fourth session on ***“Economic operation of power system”***. He explained how to distribute the plant load among the units (to make operation economical) with several numerical problems, for linear incremental fuel cost equation direct method of solution can be used for nonlinear equation iterative equations are to be used, effect of transmission loss in distributing the load among the plants, also discussed about optimal power flow (OPF). He continued his lecture with explaining hydro-thermal co-ordination with a numerical problem. At the end he discussed about Electricity market and some economic issues.

Day 3: 12th July 2017

First session was started at 9:30 am, by **Prof. S A Soman (A case study on Mumbai Transmission System)**, firstly described the background of transmission system, these evaluate the ability of phase shifting transformer (PST) to enhance transmission system

import capacity of Mumbai. Mumbai load is considered to be 4194 MW for planning purpose. Further he explained, why phase shifting transformer (PST) on a transmission line? Phase shifting transformer specialised form of transformer used to control the flow of real power on three phase electricity transmission network, other alternative which he described in this area, by altering the line impedance, by altering the voltage SVC, Unified power frequency controller(UPFC) and SSSC. In last, he explained the topic phase shifting transformer by taking the examples and figure with complex turns and without PST.

Prof. G. Bandyopadhyay started the second session at 11:15 am on **“Power System Protection”**. He discussed about the classification of relays based on logical design and hardware, requirement of high speed relaying, differential protection, and importance of line protection. Explained different type of relays such as, magnitude relay, directional relay, ratio relay, differential relay pilot relay and travelling wave based relay.

The third session of the day was presented again by, **Prof. S A Soman** at 1:45 pm on **“Phase shifting transformer”**. During this session, he discussed about phase shifting transformer, construction and principle of PST, international experience with PST. Then he explained various numerical problems related to phase shifting transformer. At the end he answered various doubts of participants of different centres.

Prof. Gautam Bandyopadhyay delivered the lecture during fourth session on **“Advance power system Protection”**. He discussed about Pilot protection with a schematic diagram of phase comparison carrier current protection, Traveling wave relay and Recent Development in Protective Relaying. A fault on the transmission line caused rapid discharging of pre – faults charge on the line. These voltages do not mal-operated during voltage instability and transient instability. He further explained **“Adaptive relaying”** which change their characteristics to suit the prevailing power system conditions. Explained various numerical examples based on monitoring and protection in power system. Session ended with questionnaire.

Day 4: 13th July 2017

Prof. N.K. Kishore, started the first session of the fourth day with **“Motivation Exercises”**. These are few questions which he answered, why we use 3-phase and poly-phase, why we use standard voltages like 132KV/220KV, why 50Hz in most parts and 60Hz in north America, why AC is Sinusoidal etc... Next, he came to product development cycle, in which he explained about steady state of art, break into component and analysis, defined requirement

and synthesis, developed prototype and test in laboratories, then he told about some good books to read. In the last he introduced FACTS a Flexible AC Transmission System, benefits of series capacitor, increase power transfer capacity and line Induction.

Second session was started at 11:15 am by **Prof. N.K. Kishore** on “**Application of software for Power System Analysis**”. During this session, he introduced *Power world Simulator software*. Explain how to use the software, and different tools of the software being used to determine the power flow. Then he described how to design a problem of power system in power world simulator software, all the participants designed the same problem and completed the simulation.

In Continuation of third session **Prof. N.K. Kishore** continued with the same topic. During this session, he again took a power system problem and simulates it on *Power World simulator software*. And then he started the questionnaire and answered the questions about the simulations.

Mr. Narayanan R (Business Analyst, TCS, Chennai) delivered the lecture during fourth session on “**Application of ICT in Power System Operation**”. Firstly, he discussed about the interaction plan, and planned to discuss about traditional utility model; Evolution of grid model with customer engagement, DER penetration and digital technology; Architecture, OT-IT-ET system Integration; Tools for implementation, process approach. He further explained about different technologies such as, IT (Information Technologies), OT (Operation Technologies) and ET (Energy Technologies). Discusses various challenges in OT Controllability; various challenges in OT Integration; Common integration Model (CIM). Then he talked about some process tools for smartening the Grid; domains of Smart Grid maturity model; Levels of Smart Grid Maturity model. Session ended with answered the question of participants from different remote center.

Day 5: 15th July 2017

Day 5: 14th July 2017

First session started at 9:30 am. Participants were given a **Quiz** to test the learning of all participants throughout the workshop. It consisted of 30 objective questions of 3 marks each i.e. a total of 90 marks. The participants had to attempt the quiz in 90 minutes under the supervision of respective remote center coordinators and IIT Kharagpur

representatives. **Prof. N K Kishore** also cleared the doubts of participants related to any of the questions in the quiz. It was finally submitted at 11 a.m.

Prof. N K Kishore started the second session at 11:15 am on ***“Overview of a Laboratory Course on Power Systems”***. In this session, he discussed how laboratory courses are supplements to theory courses not complementary and must be run parallel. He also discussed the distribution of labs in a semester, the safety instructions to be kept in mind and minimum components required. He explained about various sources of energy, sub stations, protection and supplements in power systems. In the end, he answered the queries of all participants.

The third session of the day was presented by **Prof. S A Soman** at 1:45 pm on ***“Introduction to Power Exchange”***. During this session, he talked about various power exchange products viz. day ahead market, term ahead market and renewable energy certificates trading. He then moved on to discuss about bid order structures in market i.e. block bid, linked block bid and flexible hourly bid. He explained the market equilibrium and social welfare via various graphical visualizations and hourly bid matching through Lagrangian functions. He also discussed various examples and finally answered the queries of participants.

Prof. S A Soman continued the lecture during fourth session on ***“Introduction to Power Exchange”*** at 3:30 pm. He started the lecture by talking about market splitting and discussed its example. He then explained the need of block bids with another example and its problems. He discussed further examples based on non-existence of equilibrium price and Paradoxically Rejected Bids (PRBs). The participants also learned about the enumeration and heuristic solution approach and MILP approach. The session was ended after the doubts of all participants were cleared by Prof. Soman.

Day 6: 15th July 2017

First session was started at 9:30 AM by **Prof. N. K. Kishore** on ***“Renewable energy Conversion Transmission and Storage”***. Firstly, he discussed about how to solve any problem; break into components first, representation (Mathematical, Circuit representation, EM), Analysis (Performance, Efficiency), Synthesis (Inverse), Design and finally Prototype. He also discussed about some National Energy policies (Niti Ayog), Security of energy and some Renewable Energy resources. Next, discussed about objective of Renewable energy, Energy States and also explained about the energy deficiency during peak hours and how this deficiency can be compensated. At the end he showed some data in form of charts and

graphs showing the energy generation and consumption in India from different energy resources like Solar, Thermal (under thermal also coal, gas etc.), Hydro etc.

Prof. Kannan M Moudgalya (*Professor, Chemical Engineering Department, IIT Bombay*) started the second session at 11:15 AM on “**SciLab**”. He started the session by introducing the SciLab and uses of Open Source Software. Also he discussed the benefits of SciLab like, it is freely available, no piracy etc. Then he continued with explaining about the basics of SciLab, showed some reading material. Next, he explained the implementation of a control problem in SciLab with an example. Also told the participants about the availability of SciLab lectures on Spoken Tutorials. The session came to an end with a series of questions from the participants.

During valedictory session, following distinguish guest were present.

- **Prof. Raja Datta** (*Principal Investigator, IIT Kharagpur*),
- **Prof. Pranab Kumar Dutta** (*HOD, Department of Electrical Engineering, IIT Kharagpur*), **Prof. N. K. Kishore** (*IIT Kharagpur*),
- **Prof. S. A. Soman** (*IIT Bombay*) and
- **Prof. Shailendra Kumar Varshney** (*Associate Professor, Dept. of Electronics & Electrical Communication Engineering, IIT Kharagpur*)

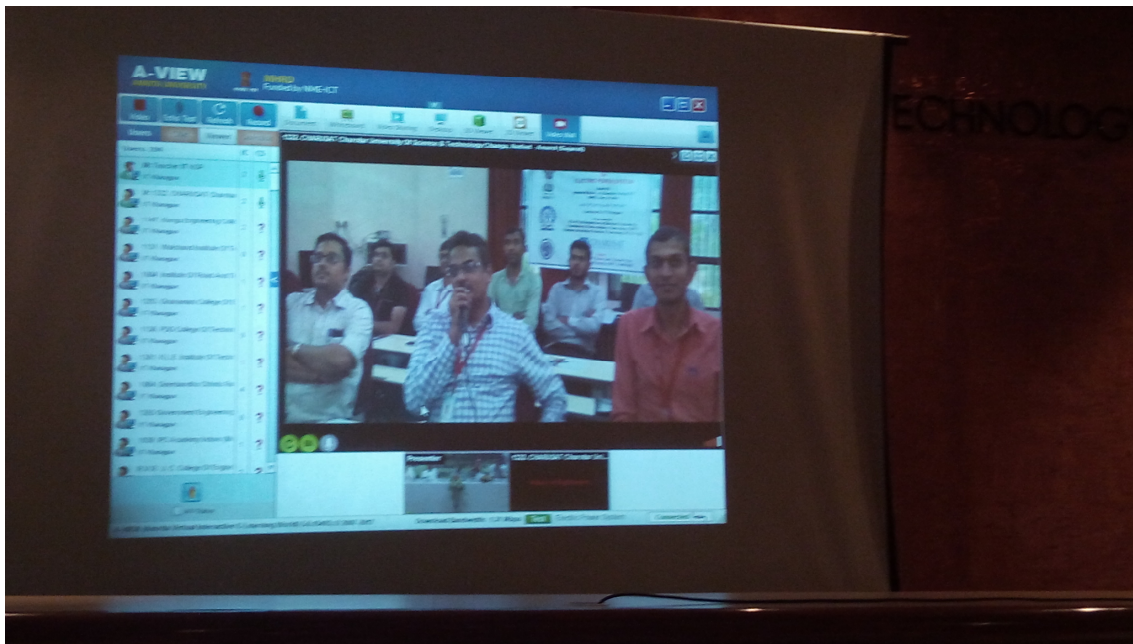
They congratulated all the participants and his team members for their successful conduction of the workshop. He also sought feedback for the workshop from the participants.

On the closing ceremony, **Prof. Naman B. Bhatt** (*Assistant Professor, EED*) presented the provisional certificate to the participants of the workshop and thanked them for sparing their precious time for the program and said that the workshop was very beneficial to all the participants which in turn will be beneficial for the students too.

I am sincerely thankful to respected principal madam, Dr. Vaishali Mungurwadi for permitting us to organize Workshop. I also thank **Prof. (Dr.) Shabir S. Bohra**, HOD, Electrical Engineering Department for providing support during the organization of the Workshop. Last but not the least, I thank all my staff members, lab assistants and attendants for their support and help during the Workshop.

Glimpses of the Workshop:







End is not the end, in fact E.N.D. means “Effort Never Dies”

---Dr. A P J Abdul Kalam