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A. Mechanical

Safety Analysis of Boiler and Turbine of Thermal Power Stations

Mahesh Prasad*

In this M tech project 'Safety analysis of Boiler and Turbine in thermal power station' has been carried out. Hazard identification procedures Hazard and operability (HAZOP) studies, Failure mode and effects analysis (FMEA) and Fault tree analysis (FTA) have been applied to identify the hazards and hazard identifying events that could lead to catastrophic failures.

In addition, use of graph / digraph modeling has been made to represent safety of boiler and turbine system. This in conjunction with matrix approach has helped to obtain an expression, i.e. permanent function, to represent structure of the boiler and turbine, containing terms, which consist of safety attributes and their influence. Safety index of the boiler and turbine system is obtained by substituting the value of safety attributes and their influence in the expression. Safety critical index for each safety system is obtained by considering the influence of each safety system on the other. This helps to guide the plant personnel in safe operation by choosing appropriate maintenance strategy.

The project will of a great help to operation and maintenance personnel for keeping boiler& turbine and their auxiliaries under safe conditions. This will not only keep the equipment safe but will also help in safety of human beings.

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Mathematical Modeling of Furnace Draft and Study of its Effect on Boiler Performance

Lal Bahadur Sah*

The effect of design and off-design conditions in a coal based tangentially fired steam generator, on pressure distribution in draught systems of the furnace is studied in this project. Further, the effect of furnace vacuum on combustion kinetics is also studied. An effort is made to quantify the changes in the power consumption by ID and FD fans due to variation in pressure distribution in draught system. Efforts are also made to quantify the effect of furnace vacuum on emission levels of unburned carbon. It has been observed that there is reduction in unburned carbon in fly ash and slight increase in flue gas temperature; however no significant change observed in CO emission with increase in furnace draught. As the change in furnace vacuum will also cause a change in Induced draft (ID) and Forced draft (FD) fan loading, pressure drop assessment for entire secondary air and flue gas path has been made to ascertain change in fan power.

Mathematical modeling and programming of the models have been done for pressure drop & fan power calculation for 210 MW boiler and actual pressure drop has been calculated & compared with design values. A close agreement has been observed between actual and design values of pressure drop for secondary air and flue gas path at full load as well part load. Mathematical modeling of combustion and boiler efficiency has also been done and a net saving in energy observed by increasing the furnace vacuum.

Keywords: Boiler, furnace vacuum, combustion, secondary air, flue gas, pressure drop.

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Analysis of Performance and Operation of Steam Generator in Low Oxygen Regime

N.N.Sinha*

From Boiler (economizer) outlet to ID fan inlet, the entire path (Air Pre-Heater, Electro Static Precipitator and adjoining ducts) runs under vacuum which is maximum at ID fan inlet and gradually diminishes upto the economizer outlet. So the entire path is subjected to possibility of air ingress in case of any leakage. Due to air ingress in flue gas path (more predominant in Air Pre-heaters due to faulty seals and in flue gas duct due to duct erosion) and subsequently overloading of ID fans, power plant engineers sometimes operate the Boiler at below recommended value of flue gas oxygen. It may lead to less Boiler efficiency and /or slagging/ clinkering problems and ultimately lead to loss of Power generation.

For slagging, coal composition plays a vital role. Inorganic matter in coal has been a major cause of problems in fuel-burning energy-conversion systems since the dawn of the Industrial Revolution. Even in the earliest days, hand-fired boilers were limited in their steaming capacity by the formation of clinkers in the fuel bed. Today, many large coal-burning power plants are restricted in steam generation by accumulations of coal ash on heat receiving surfaces. These deposits not only decrease the rate of heat transfer but they also plug gas passages and lead to metal wastage by erosion and corrosion. Ash analysis and finding out Ash deformation temp (IDT, ST, HT, and FT) and correlating to Furnace temp at different zones were done to pinpoint the safe zone of operation to avoid slagging.

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Parametric Study of 500 MW Pulverized Fuel Fired Boiler Using FLUENT

(K.Bhanuprakash)*

The Re-heater metal tube temperatures are a serious concern in a 500 MW pulverized coal fired boiler. The coal quality, or firing combination of the coal mills, these tube metal temperatures become so high that the operating staff are forced to reduce the load to control the flue gas temperatures, consequently the tube metal temperatures. While the 500 MW boiler chosen for the present project is designed to operate with Super heater spray, the re-heater is designed for zero spray operation. An attempt is made in this project to carry out 3D CFD simulations of the pulverized coal combustion for the boiler using Fluent and capture the flue gas temperatures across the heat exchangers. Using the results from CFD as inputs, re-heater tube metal temperatures are calculated using the thermal resistance concept. Simulations were also done for various operating scenarios as a parametric study to establish a data base for the flue gas temperature distributions across the various heat exchangers. The results from these simulations are validated against the designers predicted performance data and also against available actual test data results from the site.

The results indicate a strong validation of the models developed and the calculated metal temperatures, this form a good case of performing CFD simulations for developing a what if analysis tool for the tangential pulverized coal fired boiler. Such models when developed will enhance the knowledge base of the operating staff and also aid as a scientific tool for technical decision on boilers.

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Numerical Analysis of Transient Heat Conduction in Electrical Motors

K S R Subudhi*

In the recent years induction machines transient thermal analysis has been a subject of interest for machine designers in their effort to improve machine reliability. It is essential to know the locations and magnitudes of hotspot temperatures for optimum design of the machines. An analytical method has been used for ventilation and cooling system. This has been solved by fluid flow network model which yields a good agreement with the practical values. This new method separates the ventilation system from its thermal model. Finite volume coding was prepared for a 3– Dimensional transient condition to solve the internal temperature of said induction motor. Results are showing the locations of hotspots, variations of temperatures in all three directions and with time.

Keywords: Thermal analysis, Transient, Finite volume method, Induction machines.

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Analysis of Superheater Temperature Shortfall and Temperature Imbalance in a 500MWe Boiler using CFD

Pradipta Kumar Behera*

Tangentially fired drum type forced circulation boiler is one of the most widely used boilers in India. Problems normally faced during their operation are superheater/reheater temperature imbalance and shortfall, uneven heat absorption, flow variation, high metal temperature, higher superheater/reheater spray requirements, high dry flue gas losses and high erosion of tubes. The reason for these problems are still not clear & has been attributed to residual swirl, gas temperature stratification and change in coal quality. The reasons for these problems need to be investigated and suitable remedies are to be found. However, an experimental investigation on a working boiler is expensive, time consuming and nearly impossible. These problems can be easily investigated and analyzed by modeling and simulating the power plant. CFD provides a powerful tool to analyze the problem. Previously CFD modeling approach was used to predict the temperature/pressure/velocity profile inside the furnace. The results of the previous works demonstrate the capability at CFD modeling to analyze and recommend some solution for superheater temperature shortfall and imbalance.

This work involves 3-D CFD modeling of 500MWe two pass, sub-critical, tangential, pulverized fuel fired, controlled circulation, single reheat, dry bottom type steam generator installed at the VSTPP stage-II power plants using Fluent software.

The work successfully models the steam generator. Combustion is modeled for 20.5%, 14% & 10% moisture. This work showed that the heat release and temperature in burner region of the model is sensitive to the moisture percentage in the coal. As the moisture percentage of coal decreases the heat liberation as well as temperature in the model increases. Further coal data played a major role in the modeling success. The moisture percentage in the coal may be over estimated at the expense of other coal constitutes.

This work is able to show the correct modification among the three options (option-I-addition of wall superheater, option-II-addition of wall superheater & removal of RH tubes, Option-III-Addition of LTSH tube banks) to overcome the temperature shortfall at superheater outlet. It successfully predicts case-II modification as being the best in terms of heat absorption, furnace outlet temperature & pressure drop in the existing furnace. This work is able to show that there is further reduction in furnace outlet temperature due to the modification. This work also suggests different methods to overcome superheater outlet temperature imbalance.

This work also identifies the swirling zones in the furnace which are responsible for gas temperature & steam temperature variation.

This work can be successfully used in future to analyze the performance and gas distribution on different situations like coal composition, mill combination, burner position and operating condition variation. Further this work can be successfully used to analyze the effect of gas biasing or installation of flow smoothen screens in the boiler on flow/temperature/superheater temperature imbalance.

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Rankine Cycle Based Power Plant Performance Modeling

Sanjay Jain*

Mathematical thermodynamic models of the power plant equipments and cycle i.e., turbine, feedwater heaters, condenser and entire turbine cycle has been developed. These models would predict the expected performance level of the power plant cycle and equipments i.e. given the current operating conditions what should be the output and efficiency of the power plant cycle and equipments. A heat and mass balance code is also developed to calculate the current performance of equipments from measured data in power plant. The expected performance of power plant equipments and Rankine cycle are estimated from respective equipment models. Comparing expected and current performance shortfall in performance of power plant cycle and equipment is assessed.

Work has been done for a NTPC 500 MW unit. The equipment models developed are able to predict the turbine power, heat rate, mass flow rates, steam extraction pressure etc., feed water heaters TTD, DCA, extraction steam flow and heat load etc. and condenser expected vacuum. The predicted values of important parameter from the equipment and cycle models are matching with the manufacturers guaranteed values. Correction curves obtained from cycle simulation also matches closely with the correction curves provided in ASME PTC-6 of steam turbine. The performance models of equipment and cycle generated in the program are able to tell about the equipment and cycle performances on the repeatable basis. The models developed in the project can be used for performance monitoring in plants.

Effects of off design conditions such as varying steam flow rate, varying main steam pressure, temperature, reheat steam temperature, varying condenser pressure, poor feedwater heater performance, varying attempration flows can be simulated from the developed power plant equipments models.

Key words: *Power plant performance modeling, Rankine cycle modeling, steam turbine model, feed water heaters models, condenser model, steam power plant off-design analysis, Rankine cycle heat balance analysis.*

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CFD Modeling of Heat pipes

Rabindra Nath Behera*

Computational Fluid Dynamics is a powerful technique for the analysis of systems involving fluid flow, heat transfer and associated phenomena by means of computer-based simulation. In order to improve the heat capacity transmitted through a heat pipe, it is necessary to know its fluid flow and heat transfer characteristics at a fundamental level.

The governing equations of continuity, momentum and energy are developed for the vapor, liquid as well as for the wall regions. The discretizations of the governing equations were carried out. Model-I is developed to simulate the vapor region of the heat pipe. Validation of the model-I is done with the available literature. Model-II is developed to simulate the vapor, liquid as well as wall regions.

The real difficulty in the solution of the differential equations lies in the unknown pressure field. In compressible flows the density" ρ" is dependent variable of the continuity equation and pressure is calculated via an equation of state. This approach is inapplicable to incompressible flow. The discretization of momentum equation in the same control volumes that contains the pressure in the cell nodal points leads to a coarser grid for pressure effect in the momentum equation. Such discretization leads to more serious problem i.e. a wavy pressure field will be felt like a uniform pressure field in the discretized equation. This problem can be handled by using staggered grid concept. Here we do not have to calculate all the variables at the same grid points. We have taken up this opportunity to solve the continuity, momentum, and energy equations for the vapor flow in a heat pipe using staggered grid concept. The computer code is developed in VC^{++} using power law scheme.

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Modeling and Simulation of Airpreheater

Niraj Krishna*

Energy savings is one of the key issues in power generation systems not only from the viewpoint of fuel consumption but also for the protection of global environment. In a power plant, poor performance of airpreheater is one of the main reasons for higher heat rate. Performance of airpreheater is significantly influenced by the quantity of leakage and its distribution.

The present work is focused on developing a computational fluid dynamics model of 500 MW bisector airpreheater, to study the individual seal leakages in airpreheater and its effect on airpreheater performance. The geometry has been prepared using Gambit. Flow and heat transfer have been studied using Fluent® software. Standard k-ε model has been used for closure of the turbulence variables.

In the first part of the project work, simulation has been carried out at different loading conditions for airpreheater with no seal leakage; this inturn provides information about carry-over leakage. In the second and the third part of the project work, simulation has been carried out at different loading conditions for airpreheater with only bypass seal leakage and radial seal leakage respectively.

Finally airpreheater with all seal leakages has been modeled and simulated at different loading conditions. The outlet temperature and pressure drop have been compared with actual data supplied by the manufacturer. Effect of variation in ambient temperature and seal clearances on leakage and its effect on airpreheater performance have been studied. Study of seal leakage on fan power consumption and boiler losses have also been carried out.

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B. Electrical

Power Quality Improvement in Variable Frequency Drive Using Hybrid Filters

G.K.Mehndiratta*

Passive filters are the most economical means used to protect the AC source from harmonic pollution, but it has its own limitations like fixed compensation, large size, problem associated with resonance etc. Moreover, designing a shunt passive filter for varying load conditions is very difficult as its performance is highly influenced by the source impedance. Active filters are very complex and costly but very effective in overcoming the limitations of passive filters especially when employed as a local solution in any distribution system. Hybrid filter comprising shunt passive and series active filter combination is a cost-effective and practical way of mitigating both current and voltage harmonics generated in a power system due to the presence of non-linear loads. In this project a practical VFD system installed for the ID fan in NTPC Dadri has been chosen as the non-linear load for which a hybrid filter comprising of a shunt passive and series active filter is employed for improving the power quality at the source end. The design of passive and series active filters have been done from scratch; their modeling has been taken up in Simulink environment and the simulation has been carried out under varying load conditions.

The topic of this work is "Power Quality Improvement in Variable Frequency Drive using Hybrid Filters". SIMULINK / MATLAB has been used for developing and simulation of the model.

A VFD system has been simulated for both 6 pulse and 12 pulse operation to study current and voltage harmonic pollution created due to the presence of non-linear elements. Initially the effect of shunt passive filter in eliminating current harmonics (and voltage harmonics as a by product) has been studied for both 6 pulse and 12 pulse operation. Shunt passive filters were able to bring power quality to acceptable level for 12 pulse operation but for 6 pulse operation a series active filter is also needed. Series active filter has been modeled and combined with shunt passive filters

for 6-pulse operation. The performances of Hybrid filter in mitigating both current and voltage harmonics has been studied for the VFD system in 6-pulse mode.

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Congestion Management in Restructured Power Systems

N.N.M.Rao*

The restructuring in electric power industry has led to intensive usage of transmission grids. In deregulated electricity market, most of the time power system operates near its rated capacity as each player in the market is trying to gain as much as possible by full utilization of existing resources. Congestion or overload in one or more transmission lines may occur due to the lack of coordination between generation and transmission utilities or as a result of unexpected contingencies such as generation outages, sudden increase of load demand, or failure of equipments. Therefore, congestion management is one of the key functions of any system operator (SO) in the restructured power industry.

In this report, Evolutionary Programming (EP) method is used to alleviate transmission congestion by a modified Optimal Power Flow (OPF) whose objective is to minimize the absolute MW of redispatch. This is demonstrated on IEEE 5 bus system. Further, the solutions for Economic dispatch under deregulatory environment are demonstrated by applying Particle swarm optimization (PSO) method. This is done on IEEE30 bus system considering different cost characteristic curves of generators.

The preferred schedules of generations are obtained under economic dispatch environment and congestion due to introduction of transactions is solved by reschedule of generations with minimum congestion cost according to incremental and decremental bids submitted by the generators. Further, the congestion management is demonstrated by minimum curtailment of transactions and minimum curtailment of native load, without altering the preferred schedules of generators. This is done on IEEE30 bus system by applying PSO method.

In this report, multi objective optimization by using Non-dominated Sorting Genetic Algorithm (NSGA-II) is used to get the no. of Pareto optimal solutions with the objectives of minimum congestion cost and minimum curtailment of transactions. This

provides the choice to operator to take judicious decisions. The proposed algorithm is demonstrated on IEEE-30 bus system with bilateral and multilateral transactions.

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Phaselet Based Distance Relaying Algorithm

S.P.S.Pundir*

This thesis deals with the development of variable window phaselet based algorithm for distance protection of EHV lines. Investigation has been carried out considering 400 kv, 300 km transmission line. The performance of phaselet based algorithm is compared with full cycle algorithm. The performance of proposed algorithm is examined considering variation in fault inception time, fault location for mho and reactance type relay. The effect of variation of sampling frequency is also examined. Investigation shows that variable window phaselet based algorithm is faster than fixed width full cycle window based algorithm.

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Analysis of Wind Turbine Driven Doubly Fed Induction Generator

Navin Kishore*

This thesis deals with modeling and control of wind turbine driven doubly fed induction generator (DFIG). It consists of two controllers to control grid side converter and rotor side converter.

Wind electric energy conversion system (WECS) by its characteristics needs to be operated at different generator speeds in order to harness maximum output. Thus the need of DFIG arises which can be run efficiently and be controlled easily. Stator windings are directly connected to the grid and the rotor windings are connected through ac-dc-ac link, namely rotor side converter, dc link capacitor and grid side converter. Both the converters are voltage source converters.

The rotor side converter control system is for control of torque, reactive power and current. The current control loop is a fast control loop. In the reactive power control actual reactive power is compared with the reference reactive power. This reference reactive power is set as instantaneous reactive power requirement of the DFIG. The grid side converter keeps dc link voltage constant in order to keep active power balance. The response of wind turbine driven DFIG was observed at different wind speeds. Pitch angle control was also observed.

Different models of DFIG were studied. Some of them were used for decoupled control of active and reactive power. Some of these concentrate on minimizing the losses incurred in magnetizing.

Keywords: Doubly fed induction generator, wind turbine, wind energy, current control, torque control, reactive power control, WECS.

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Analysis of Rihand-Dadri HVDC System

F.Rahman*

This project deals with the modeling and simulation of Rihand-Dadri HVDC system for understanding, evaluating its performance and suggesting some improvements if it is economical and practically feasible. Rihand-Dadri HVDC system has a capacity of 1500 MW at the transmission voltage of ± 500 kV bipolar with the current being 1.568 kA at full load. The objective of Rihand-Dadri HVDC bipole is to evacuate power from 2000 MW Rihand super thermal power project over a distance of 815 kilometers. HVDC transmission systems have been gaining a lot of popularity due to their advantages like less loss, reduction of corridor requirements and possibility to connect two systems having different frequencies. Reduction of corridor will benefit from environmental clearance point of view (less deforesting). Generally 12-pulse, thyristor converters (rectifier and inverter) is being used for DC power transfer. These converters inject current harmonics to ac side and voltage harmonics to DC side. At present, most of the HVDC projects are equipped with passive shunt filters for mitigation of power system harmonics. HVDC system has been modeled and simulated in MATLAB/SIMULINK as well as PSCAD/EMTDC environments to observe the effects of harmonics on the system and also to compare the results obtained from both the simulation tools. It is observed from both the software packages that simulation results are almost matching with respect to voltage and current harmonics. In the simulation results from both software tools, the source sides THD are almost equal and it is well within IEEE standards. As the same results are obtained from both software tools, the results have been corroborated. From the simulation results obtained from both the software tools, it is observed that the secondary side voltage and current harmonic distortions are way beyond allowable limits. The THD is about 20% in the secondary side even with all the passive filters in service at primary side at full load and also at varying load conditions. This Rihand-Dadri HVDC system has seen so many failures of converter transformer secondary windings. Initially, most of

the failures were in delta secondary winding; there were some failures in star winding also. It is worth mentioning here that delta winding is connected to the lowest voltage (ground) of the valve and star winding to the highest voltage (500kV) of the converter. Since most of the failures reported are on the secondary side, it was decided to study the various phenomenons happening between thyristor valve and the secondary of the converter transformer. Therefore we have focused mainly to reduce voltage and current THD in the secondary of converter transformer. It is seen that rate of change of voltage with respect to time in the secondary side is quite high due to the commutation overlap of the converters which is cyclic in nature. This is due to high value of source impedance which cannot be ignored. Such over voltages are normally expected and considered in the designed of insulation of the system. It is seen that at lower power level rather than at 1 pu power, current and voltage THD levels are more.

The following solutions have been tried out to minimize the harmonic burden on the secondary winding of the converter transformer:

(i) A capacitor has been inserted across the DC link of the converter; but no marked improvement in THD of secondary side is observed with this solution; but dv/dt and voltage spikes are getting reduced. Such an application could be similar to capacitor commutated converter which has not been considered under present scope of our discussion.

(ii) Since two numbers 6 pulse bridges are connected in service with a phase shift of 30°, the predominant harmonics in 6 Pulse Bridge (i.e., on the secondary side) will be 5^{th} and 7^{th}. Therefore passive filters of 5^{th} and 7^{th} harmonic order are incorporated in the secondary side of converter transformer. In this case, there is a substantial improvement in current harmonics (this gets reduced to 8% from the original 20%) and voltage harmonics reduced marginally. Since major harmonics source is 6 pulse converter and 5^{th},7^{th} harmonics are getting generated, once these are filtered at generating source itself it is not likely to get such harmonic transfer to primary side as 11^{th} ,13^{th}.

(iii) When these two solutions (i) and (ii) are combined together, the voltage and current THD are getting reduced to 14.34% and 5.13% respectively. Commutation overlap and dv/dt are also getting reduced.

(iv) To reduce the effect of source reactance, capacitors have been inserted in series with the primary winding of the converter transformer; in this case, the voltage THD is getting reduced substantially to 5.6% but current THD level gets deteriorated and rises to 90%.

(v) RC snubbers (in addition to valve snubber circuits) have been inserted across the secondary winding of the converter transformer; here, the voltage and current THD are reduced to 11.5% and 12.9% respectively.

The preliminary transient modeling of converter transformer of Rihand-Dadri HVDC system assuming suitable value for capacitance is done on single phase basis. From the simulation results it is obvious that top portion of the winding is getting severely stressed. It is not reflecting the actual voltage distribution in converter transformer of Rihand-Dadri system. The three phase transient modeling is needed for complete insight into the converter transformer behavior during initial period by taking actual designed data into consideration. PSCAD/EMTDC software may be in a position to throw some light on the analysis of converter transformer failure if the design parameters of these transformers and other system parameters are clearly known and a complete transient modeling of this transformer is undertaken.

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Wavelet Transform Technique for Differential Protection of Transformers in the Perspective of NTPC, Unchahar

Anand Kumar Jha*

The proposed work aims to develop a Wavelet transform technique for the protection of all types of transformers used in different power projects, against fault situation/mal-operation of relay. This is an emerging technology in the numerical/digital protection area, where FFT and some other techniques are currently widely used in the industry.

In this report an algorithm based on processing differential current is proposed for digital differential protection of power transformers by considering different behavior of the differential currents under fault and Inrush current conditions using WAVELET transform technique. Wavelet transform is a reliable and computationally efficient tool and has been used for distinguishing between inrush current and fault current.

Hence to ensure reliability of differential protection system and thus to avoid mal-operation of differential relay in protection system due to inaccurate discrimination of magnetizing inrush current and fault current in digital relay protection ,the wavelet transform based technique has to be applied on differential current to discriminate magnetizing inrush and fault current.

The transformer data have been taken from technical diary of NTPC Unchahar. Different types of fault situation have been modeled and simulated in Matlab to analyze the problem of differential protection of transformers. WAVELET packet transform technique is used for discriminating magnetizing inrush and fault current.

For large power transformers, differential protection based on circulating current principle is usually adopted. The differential protection converts the primary and secondary currents to a common base and compares them. The difference between these currents is small during normal operating conditions. The difference is also

small for external faults, but is larger than the difference existed for normal operating conditions. However, during an internal fault in a transformer, the difference becomes significant.

The wavelet packet transform is used to extract certain features of the differential currents to distinguish between magnetizing inrush and different faults.

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Facts Devices Modeling & Control to Improve the Power System Performance

S.S.Bhadoriya*

This thesis deals with the design of STATCOM controllers to enhance the power system stability. STATCOM is a voltage source inverter which generates a controllable voltage to control the bus voltage as well as other parameters of the power system.

Dynamic modeling of SMIB power system with STATCOM has been developed in synchronously rotating frame of references. A systematic approach for developing PI & a Fuzzy Controller for the STATCOM has been presented. The PI controller tuned for the STATCOM is a fixed gain controller which may work satisfactorily for a given operating condition or for a particular type of disturbance. However the performance of the same PI controller may not be so effective for another operating condition of the system or for another type of disturbance. This leads to design of an fuzzy controller, which is essentially an adaptive type of PI controller, where the gains of the controller are adapted automatically depending upon the system operating condition as well as with the nature of the disturbance.

Investigation shows that under different operating condition & fault type STATCOM with Fuzzy control results in better system response compared with cascade PI controller.

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Analysis of SSR Phenomenon and Protection OF Generator against SSR

Ram Krishna Niranjan*

The proposed work aims to develop a protection for generator against SSR phenomenon which is quite prevalent in case of series compensated lines. This can also occur in case of HVDC lines. To analyze the problem a series compensated lines has been modeled and simulated in MATLAB SIMULINK. Small perturbation analysis has been done by forming A matrix for turbo generator shaft as different masses coupled together. This gives of various modes of oscillation of the turbine generator shaft. The mathematical modeling of generator and transmission line has been done to form a complete system A matrix. The eigen values of the A matrix gives not only the different frequency components but also their dampings (real part of eigen values).some of the frequencies have been found near natural modes of oscillations of the considered turbo generator mass system.

A simulation model for SMIB (Single Machine Infinite Bus) system developed in SIMULINK has been used to analyze the effect of varying series compensation, line resistance, generator rotor resistances and adding another uncompensated line in the system on SSR occurrences. A series resonance scheme has also been modeled in SIMULINK to reduce the potential of SSR. The scheme offers unbalance three phase impedances to sub synchronous frequency components of current reducing the coupling between mechanical and electrical system.

The observations made by the work suggest the requirement of generator protection against SSR. Three types of generator protection against SSR have been considered and programs in MATLAB have been developed to process the signal from the generator and to generate a tripping command. The three protective schemes have been compared for their way of functioning.

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Developing Fault Locating Algorithm for a Series Compensated Transmission Line

Mohit Atrey*

This thesis presents fault locating algorithms for series compensated transmission lines. Studies have been carried out considering a single line with mid point compensation and end point compensations. Investigations have also been carried out for series compensated parallel transmission lines.

Two alternative Algorithms based on one end measurement data AND two end measurement data have been developed and their performance examined considering a 400 KV, 300 km long line for different fault location and types.

Studies show that the algorithm based on two end measurement data is simple and more accurate.

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On Condition Monitoring of Electric Drives Using ESA

Lalit Grover*

Condition monitoring of induction motors is a process that may be used to great advantage in mining and other industrial applications. The early detection of motor winding deterioration prior to a complete failure provides an opportunity for maintenance to be performed on a scheduled routine without the loss of production time. Presented in this paper is a theoretical and experimental analysis of a voltage mismatch technique that may be used in operating situations to monitor the health of induction motor windings. It extends previous work in this area by demonstrating the robust nature of the monitoring process not only under conditions of power supply unbalance but also in situations where motor construction imperfections exist and mechanical loads are unpredictable. A suggested procedure for application of this condition monitoring process in industrial situations is also included.

Three phase induction motor is an important drive in power plants & industrial processes. Due to high reliability requirements, efficiency and cost of breakdown, the condition monitoring of induction motors and timely diagnosis of the fault are of increasing importance. For these reasons, there has been a continually increasing interest and investigations into the fault detection and diagnosis of induction motors. This project describes the utility of online monitoring techniques such as vibration signature analysis, current spectrum analysis, voltage spectrum analysis, air gap flux spectrum analysis, voltage and current waveform analysis for detection of various stator faults. The technique applied here is based on the monitoring of the current, voltage, vibration and air gap flux of the machine when it is operating, with the help of different types of transducers such as current, voltage, vibration and search coil. The signal obtained is analyzed by FFT analyzer in frequency domain for detection of the faults. This technique is capable of detecting different types of incipient stator faults. These different stator faults are simulated in the 'MATLAB / SIMULINK' and the results are cross-verified with the

experimental results with the help of virtual instrumentation in LabView 8.2. Effect of stator faults on noise level and motor body temperature rise were also analyzed during the experiment.

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C. Control & Instrumentation

A Numerical Method for Determination of Defect Shape from Magnetic Field Measurement

R. Meganathan*

An efficient Finite element (FE) based modeling and computational scheme for defect reconstruction in Non-Destructive Evaluation (NDE) using static magnetic field is presented in this thesis. It utilizes an algorithm for efficient repetitive FE computations proposed recently. Modeling of various probable defects and computation of the most probable one using Genetic Algorithm (GA) is illustrated.

The methodology for construction of defect shapes from particular magnetic flux leakage (MFL) signals has been explained. In this work, instead of using the amplitude of magnetic field measured over certain elements, the use of directional information of magnetic field which could be easily obtained has been suggested for the determination of defect profile. Directional information of magnetic fields can be easily measured over large number of locations through small magnetic compasses or iron filings. This approach of measuring directions of magnetic field could reduce the dependence on sensors for field measurements.

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Void Fraction Measurement Sensor for Thermal Power Plant Boiler Application

Binay Jose*

Utility boilers are an integral part of a thermal power plant. Various measurements are used to ensure efficient and economical operation of utility boilers. The most important phenomenon inside boiler water wall tube is conversion of feed water into steam via nucleate boiling. Efficiency of combustion as well as overall heat transfer can be assessed from the rate of generation of steam. This involves measurement of fraction of steam present in the two phase mixture of water and steam in the boiler tubes. Void fraction is defined as the ratio of volume of the gaseous phase to total volume in a two phase mixture. Owing to manifold difficulties associated with void fraction measurement under high pressure and high temperature operating conditions at boiler tube, no such measurements are commercially available as on date.

The present work is an attempt to find a suitable sensor for measurement of void fraction for two phase flow in vertical metallic tubes. Various measurement methods for void fraction from literature were evaluated and capacitive sensing method was selected for current case. Experiments were conducted in laboratory scale using a water flow loop. Voids were created initially through steam production by means of heaters connected to piping and later by bubbling of air / nitrogen gas. Different probe geometries were investigated for sensitivity towards operating void fraction range in power plant boilers and most favorable probe shape for the project was arrived at. Difficulties were faced in obtaining a perfect insulation material. Available insulation materials are prone to degradation in their properties with rise in temperature. Probe designs started with HydraStep based horizontal type and culminated in a vertical tubular design which exhibited good sensitivity at low range of void fractions. This probe was connected as part of oscillator so that variation in capacitance gets translated to change in frequency. Controlled nitrogen bubbling was

directed precisely to the probe immersed in static water to arrive at a correlation between observed frequency and nitrogen flow.

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* *Sh Binay Jose is presently working as Manager at NTPC Simhadri*

Defect Shape Construction for NDT Using Eddy Current

Dibyendu Guha*

Whenever metallic objects like pipes and blades are subjected to high pressures and temperatures for prolonged time intervals cracks and defects appear on their surfaces which are to be attended timely by maintenance personnel to prevent equipment failure. One of the main challenges before the maintenance personnel is to understand the shape of the defect based on some measurements done with the help of some instruments near the cracked surface. This project will present the ways and means to determine the shape of the defect based on measurements of electric potentials near the crack shape. For this I have first developed the F.E. model that computes the electric potential (from the magnetic vector potential at the nodal points of the F. E. model) at the test coil positions for different crack shapes. After this I have used GA and Neural Network based techniques to find out the defect shape corresponding to the readings of the test coils near the defect shape.

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* *Sh Dibyendu Guha is presently working as Dy Manager at NTPC Jhajjar*

Design and Testing of Model Predictive Controller for Main Steam Temperature Control in Coal Fired Power Plants for a Drum Type Boiler-Comparison of ANN MPC and Physical Principle MPC

M.Karikalchozhan*

One of the most difficult loops in a modern power plant is that of controlling superheated steam temperature. The efficiency of the power generating station depends strongly on maximizing this temperature, but within very tight limits. The temperature allowed is limited by the ability of the steel-alloy heat transfer tubing, retaining its strength. Excessive temperature and especially temperature variations, cause stress and distortion which can significantly shorten the life-spam of the super heater. Hence enormous attention is being paid to control the temperature as close as to design value. Dynamic simulation models using powerful personal digital computers are a very cost effective tool for studying the operating characteristics of power plants to improve the design and control strategy to meet stringent operational requirements. The required operating modes of large fossil fuelled generating plants call for continued operation after load rejection, and rapid, frequent and reliable unit start-ups to achieve flexible and economic production of electricity. As modern plants are provided with sophisticated sensors and data acquisition system, it is easy to implement ANN based MPC without any difficulty. In this project an attempt is made to show that ANN based MPC works as efficient as physical model based MPC. A fossil fuel plant model was designed using ANN and also based on physical principle. Both techniques are studied and compared with a real plant. Simulations are carried out using real world data.

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* *Sh M Karikalchozhan is presently working as Dy Manager at NTPC Ramagundam*

Efficiency Estimation of Decision Making Units with Imprecise Data using Fuzzy DEA approach

S.K.Behera*

Data Envelopment Analysis (DEA) has emerged as a powerful tool for measurement and performance improvement of production units. DEA can quantitatively measure the relative efficiency of decision making units and identify the efficient units which can be benchmarked by the inefficient units for performance improvement. Traditional DEA requires precise input and output data. In real world situations, very often situations arise where number of input and output variables are defined in linguistic terms, have ordinal values or imprecise in nature e.g. satisfaction levels, health of equipment, competency level of employees, etc. To account for the vagueness of data, the power of fuzzy logic has been combined with the conventional DEA framework, giving rise to an interesting formulation called fuzzy DEA. Several approaches have been developed to solve the FDEA problems. In this project an attempt has been made to explore various models available for handling fuzzy data and evaluate the technical efficiencies of DMUs using the α-cut approach of Kao and Liu using a sample dataset. The case of the efficiency estimation of the coal based thermal power stations is done using the conventional DEA framework, the results compared with the previous studies using different methods. The imprecise inputs are modeled in the FDEA framework.

* *Sh SK Behra is presently working as Manager at Energy Technology-CC*

APPENDIX-I

LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR FIRST (1998- 1999) BATCH

Sl No.	*Name of Project*	*Student*	*Supervisor (s)*
1.	*Combined Power Cycle with Integrated Methanol Plant; A conceptual approach for reduction of carbon dioxide*	*-D.M.R. Panda*	*-Dr. D. K. Sharma, IIT*
2.	*System design of a 100 MW IGCC demonstration Plant*	*-Sarit Maheshwari*	*-Dr. D. K. Sharma, IIT*
3.	*Optimation of steam power plant cycles using super critical steam*	*-Rajeev Satyakam*	*-Dr. Ashok Malhotra, IIT*
4.	*Performance simulation of once through super critical steam generator*	*-Santanu Dandapat*	*-Dr. Ashok Malhotra, IIT*
5.	*Development of software for performance analysis of steam generator combustion system*	*-S. K. Singh*	*-Dr. P.M.V. Subbarao, IIT*
6.	*Radiation and convective analysis of location of boiler superheated in a steam generator*	*-K. B. Singh*	*-Dr. P.M.V. Subbarao, IIT*
7.	*Investigation of coal ignition phenomena*	*-V.M. Choudhury*	*-Dr. Anajan Ray, IIT*
8.	*The effect of impulse and reaction stages on steam turbine performance*	*-M. K. Asthana*	*-Dr. S. M. Yahya, IIT*
9.	*Development of a computer software for rating of a water cooled surface condenser*	*-Ashok K Sehgal*	*-Dr. M. R. Ravi, IIT*
10.	*Flow analysis of a 3 D rectangular diffuser mounted downstream of LP Turbine using Computational Fluid Dynamics (CFD)*	*-Subodh Kumar*	*-Dr. Lajpat Rai, IIT*
11.	*Application of Reliability Centered Maintenance (RCM) to power plant auxiliaries*	*-P. Rajesh*	*-Dr. G. S. Yadav, IIT*
Sl No.	*Name of Project*	*Student*	*Supervisor (s)*
12.	*Automatic Generation Control (ACG) of an interconnected power system with AC-DC links and effect of deregulation*	*-T. R. Rajgopalan*	*-Dr. M. L. Kothari, IIT*
13.	*On some aspects of Automatic Generation Control (AGC) of a two area system*	*-A. K. Kulshreshtha*	*-Dr. J. Nanda, IIT*
14.	*On some aspects of Automatic Generation Control (AGC) of a two area thermal system*	*-Ajay K. Agrawal*	*-Dr. J. Nanda, IIT*
15.	*Steady state performance analysis of parallel operated STATCON units*	*-Deepak Tiku*	*-Dr. Sanjoy Roy, IIT*
16.	*Performance evaluation of computer relaying algorithms for distance protection and development of a microprocessor based distance relay*	*-B. M. Singh*	*-Dr. M.L. Kothari, IIT, Dr. S.M. K. Rehman, IIT*

17.	*Single and dual input power system stabilizers*	*-Arun Kumar Garg*	*-Dr. M.L. Kothari, IIT*
18.	*Steady state voltage stability analysis*	*-Savish Kumar Jain*	*-Dr. P. R. Bijwe, IIT*
19.	*Tuning of excitation system*	*-V. P. Ravindranathan*	*-Dr. M. L. Kothari, IIT*
20.	*Condition monitoring of power transformers*	*- P. K Goyal*	*-Dr. M.L. Kothari, IIT, Mr. N.V.C. Sastry, NTPC*
21.	*Condition monitoring and protection of motors*	*- Charanjeet Singh*	*-Dr. S.S. Murthy, IIT, Dr. Suneet Tuli, IIT*
22.	*Application of passive and active thermography in power plants*	*-Alok Shrivastava*	*-Dr. Suneet Tuli, IIT*
23.	*RF power line carrier communication*	*-S. Satheesh*	*-Dr. A. K. Agarwala, IIT*
24.	*Simulation of drum level control and tripping system of a 200 MW steam generator*	*-K. Nageshwar Rao*	*-Dr. PMV Subba Rao, IIT Dr. I. N. Kar, IIT*

APPENDIX-II

LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR SECOND (1999- 2000) BATCH

Sl No.	*Name of Project*	*Student*	*Supervisor (s)*
	Study and thermodynamic analysis of alternative layouts for combined cycle power plants and their parametric optimization	*-Sachin Mohapatra*	*-Dr. P.M.V. Subbarao, IIT*
	Economics of multiple steam generators in thermal power plants	*-S. S. Mishra*	*-Dr Ashok Malhotra & Dr G. S. Yadav, IIT*
	Investigation of bubbling fluidized bed combustion	*-Ispaul Uppal*	*-Dr Anjan Ray, IIT*
	Investigation of group ignition phenomena of a cloud of coal particles	*-Bhola Nath Mishra*	*-Dr Anjan Ray, IIT*
	Gas side fluid flow and heat transfer analysis of a steam generator	*-R. P. Tripathi*	*-Dr M. R. Ravi, IIT*
	Prediction of off-design performance of steam turbine	*-K. S. Ramaswamy*	*-Dr Lajpat Rai, IIT*
	Optimization of super critical steam power cycle with placement of feedwater heaters	*-M. C. Karan*	*-Dr Ashok Malhotra, IIT*
	Performance assessment and analysis of high pressure feedwater heaters	*-S. Surya Narayana*	*-Dr. S. R. Kale, IIT*
	Development of a quasi three dimensional rating programme for a water cooled two pass underslug steam surface condenser	*-Ashok Sarkar*	*-Dr M. R. Ravi, IIT*
	Analysis of flow and dust removal in electrostatic precipitators	*-B. C. Roy*	*-Dr P.M.V. Subbarao, IIT*
	Some studies of coolant flow for alternator cooling and design of fans	*-Somnath Das*	*-Dr S. M. Yahya, IIT*
	Thermal stress monitoring of steam turbine rotors	*-K. Chandramouli*	*-Dr. Nisar Ahmed, IIT Dr. Lajpat Rai, IIT*
	A neural network based on-line model for heat rate estimation of power plant	*-S. S. Rao*	*-Dr. O.P. Gandhi, IIT & Dr. Jaydeva, IIT*
	Development of PC based data acquisition system for rotor dynamics	*-U. K. Bhoumik*	*-Dr. S. P. Singh IIT*
	Design and study of a fuzzy logic controller for the feed water flow control loop for 200 MW steam generators	*-S. K. Bhattacharyajee*	*-Dr. Nisar Ahmed, IIT Dr. PMV Subbarao, IIT*

	Power generation using biomass engine and self excited induction generator (SEIG)	*-B. M. Gulati*	*-Dr. S. S. Murthy, IIT*
	Investigation of self excited induction generator (SEIG) for micro hydel power generation	*-Ravindra Sharma*	*-Dr. S. S. Murthy, IIT*
	Investigations on electrical energy audit and efficiency aspects of induction motors	*-V. Ganesh*	*-Dr. S. S. Murthy, IIT*
	Dynamic simulation of voltage controlled induction motor	*-V. K, Kanungo*	*-Dr. G. Bhubaneswari, IIT*
	Condition monitoring of induction motor	*-B. B. Sachdev*	*-Dr. S. S. Murthy, IIT*
	Condition of monitoring of power transformers (artificial neural network based diagnosis of transformer faults using DGA and acoustic partial discharge detection)	*-Kausic Mandal*	*-Dr. M. L. Kothari, IIT, Mr. A. K. Mittal, NTPC*
	Delta–Omega (Δ-ω) and Delta-ρ-Omega (Δ-ρ-ω) power system stabiliser	*-Yogesh Kumar*	*-Dr M. L. Kothari, IIT*
	On some aspect of unit commitment using dynamic programming	*-B. B. Chugh*	*-Dr. J. Nanda, IIT*
	Dynamic performance evaluation of a combined cycle power plant connected to a power system	*-Bhupendra Jain*	*-Dr.R. Balasubramaniyan, IIT*
	Economic load dispatch using linear programming	*-A. N. Goyal*	*-Dr. J. Nanda, IIT*

APPENDIX-III
LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR THIRD (2000- 2001) BATCH

Sl No.	Name of Project	Student	Supervisor (s)
1.	Simulation of transient heat transfer in high pressure casing of a steam turbine	-S. D. Joshi	-Dr. Sangeeta Kohli, IIT
2	Simulation of waste heat recovery power generation cycle	-T. K. Ray	-Dr. P.M.V. Subbarao, IIT
3	Development of software for prediction of the off design performance of steam turbine	-Om Prakash	-Dr. Lajpat Rai, IIT
4	Draft fans in thermal power plants and CAD for centrifugal draft fans	-Rajesh Jain	-Dr. S. M. Yahya, IIT
5	Merit order analysis of steam boiler furnaces of thermal power plant	-Dibyendu Nath	-Dr. PMV Subbarao, IIT
6	Application of reliability centred maintenance (RCM) to power plant auxiliaries- P. A. Fan	-Prem Chand	-Dr. G. S. Yadav, IIT
7	Reduction of unburnt carbon in ash in coal fired boiler	-R. K. Jha	-Dr. K. Gadgil, IIT
8	Investigation of transient ignition phenomena of isolated coal particle	-Brajesh Singh	-Dr Anjan Ray, IIT
9	Two-dimensional simulation studies of combustion aspects of pulverised coal fired combustors	-Joydeep Ghosh	-Dr. Anjan Roy, IIT
10	Studies on SOx and particulate matter control from a coal fired power plant	-Atin Kundu	-Dr. J. P. Subramaniam, IIT
11.	NOx formation and control from coal fired power plants	-M. K. Pattanayak	-Dr. J. P. Subramaniam, IIT
12	Detection and estimation of leakage in control valves	-A. R. Gupta	-Dr. Suneet Tuli, IIT , Mr. Pankaj Bharatia and Mr. A. K. Mittal, NTPC
13	Probability of failure in service and condition assessment of generator transformer at Talcher-Kaniha Station of NTPC by using artificial neural network	-Sridhar Jena	-Dr. M. P. Dave, IIT
14	Condition monitoring of induction motor	-H. S. Sahu	-Dr. Bhim Singh, IIT Dr. G. S. Yadav, IIT
15.	Condition monitoring of power transformer (artificial neural network based fault analysis of transformer using dissolved gas analysis)	-S. K. Sen	-Dr M. L. Kothari, IIT
16	Quantitative assessment of reliability for a large thermal power station and measures to enhance availability	-Mannalal Ash	-Dr. R.Balasubramaniyan, IIT
17	Unit commitment using knowledge based genetic algorithms including probabilistic operating reserve	-C. S. Thomas	-Dr. R. Balasubramaniyan, IIT

18	*Energy audit and energy conservation aspects of drives in power stations*	*-Dinesh Kumar*	*-Dr S. S. Murthy, IIT*
19	*Neural network based modeling of 210 MW boiler-turbine unit*	*-S. P. Karna*	*-Dr Nisar Ahmed, IIT*
20	*Fuzzy logic based speed control of a chopper fed DC motor*	*-P. S. Sivaprasad*	*-Dr. Bhim Singh, IIT*
21	*Modeling and analysis of capacitor self excited induction generator for microhydel and standalone applications using Matlab*	*-Sunil H. Malani*	*-Dr S. S. Murthy, IIT*
22	*Short term load forecasting using artificial neural network*	*-Sanjib Kumar Suar*	*-Dr M. P. Dave, IIT*
23	*Damping of sub synchronous oscillations in series compensated transmission systems: The NGH scheme.*	*-S. K. Saha*	*-Dr M. L. Kothari, IIT*
24.	*Simulation on some aspect of power system with SVC using PSCAD /EMTDC*	*-Anil Kumar*	*-Dr M. P. Dave, IIT*
25	*Automatic generation Control (AGC) in deregulated power system*	*-Santanu Das*	*-Dr M. L. Kothari, IIT*

APPENDIX-IV
LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR FOURTH (2001- 2002) BATCH

Sl No.	Name of Project	Student	Supervisor (s)
1.	CFD Modeling of a 500 MWe Tangentially Fired Tower Type Boiler	-V. K. Prabodh	-Dr. M. R. Ravi, IIT
2.	Performance Prediction of High Pressure Feedwater Heaters using Computer Simulation	-Pankaj Gupta	-Dr. Sangeeta Kohli, IIT -Dr. S.K.Gupta, IIT
3.	Design of Air Cooled Condenser for Thermal Power Plant	-Hement Jethi	-Dr. Sanjeev Jain, IIT
4.	Computer Aided Study of the Effect of Ambient Conditions and the Exducers on the Performance of Combined Cycle Power Plant	-S. S. Dash	-Dr. S. M. Yahya, IIT
5.	Merit Order Analysis of Steam Turbine Systems of Thermal Power Plant	-A. K, Mishra	-Dr. PMV Subbarao, IIT
6.	Radiative Analysis of Steam Generator Furnace	-Apurba Ghosh	-Dr PMV Subbarao, IIT
7.	Modeling of Complete Combustion History of a Coal Particle in Quiescent Atmosphere	-Prakash Kumar	-Dr. Anjan Roy, IIT
8.	Developing Maintenance Audit Methodology	-Bipin Satya	-Dr. G. S. Yadav, IIT
9.	Study of Alternate Designs of Air Preheaters of Thermal Power Plants	-Rakesh Kumar	-Dr. Sanjeev Jain, IIT
10.	Oil Whirl Phenomena in 500 MW Steam Turbine Bearing	-A. C. Mohanty	-Dr. A. K, Athre, IIT -Dr. PMV Subbarao, IIT
11.	Computer Aided Design Optimization of Three Phase Induction Motors	-B. P. Sahu	-Dr Bhim Singh and Dr. B.P. Singh, IIT
12.	Economic Load Dispatch Strategy in Deregulated Environment	-R. V. Patnaik	-Dr. M.P. Dave, IIT
13.	Generation Expansion Planning using Genetic Algorithm	-R. Padmakumar	-Dr R. Balasubramanian, IIT
14.	Optimization of Power System Stabilizer by Conventional and Genetic Algorithm Based Techniques	-Prasun Chakraborty	-Dr M. L. Kothari, IIT
15.	Damping of Power System Oscillation Using PSS & FACTS based Controllers	-Bikash Biswas	-Dr M. L. Kothari, IIT

16.	*Evaluation of Station Loss of Generation Indices for a Combined Cycle Plant*	*-N. Prema Kumar*	*-Dr R. Balasubramanian, IIT*
17.	*Automatic Generation Control in Deregulated Power System using Fuzzy Logic Controller*	*-S. K. Lal*	*-Dr. M.P.Dave, IIT*
18.	*Study of TCSC (Thyrister Controlled Series Capacitor) based Compensation*	*-Devendar Goel*	*-Dr. C. M. Bhatia, IIT*
19.	*Dynamic Simulation of Direct Torque Control of Induction Motor*	*-D. K. Padhi*	*-Dr. G. Bhuvaneswari, IIT*
20.	*Probabilistic Production Costing and Optimal Trading Strategy in a Power Pool*	*-N. Vaitheeswaran*	*-Dr R. Balasubramanian, IIT*
21.	*Condition Monitoring of Power Transformers (Online Acoustic Partial Discharge Measurement and ANN based on DGA)*	*-Subhash Thakur*	*-Dr. M.L. Kothari, IIT, Mr. A. K. Mittal and Mr. Ved Prakash, NTPC*
22.	*Condition Monitoring of Bearings in Power Plant*	*-A. K. Panda*	*-Dr. Suneet Tuli, IIT, Mr. P. Bhartiya and Mr. A. K. Mittal, NTPC*
23.	*Condition Monitoring of UPS Battery Bank in Power Plants*	*-B. L. Swamy*	*-Dr. Suneet Tuli, IIT, Mr. P. Bhartiya and Mr. Ved Prakash, NTPC*
24.	*On Line Efficiency Estimation and Data Acquisition of Induction Motor through PLC*	*-Sk. Moimur Sultan*	*-Dr. S. S. Murthy, IIT*

APPENDIX-V
LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR FIFTH (2002- 2004) BATCH

Sl No.	*Name of Project*	*Student*	*Supervisor (s)*
1.	*Experimental Studies Related to Pulverised Coal Combustion*	*-D.K.Gupta*	*-Dr. (Mrs.) K.Gadgil, IIT*
2.	*Modeling of Complete Combustion History of a Coal Particle with High Ash Content in a Quiescent Atmosphere*	*-Pankaj P.Ekbote*	*-Dr. Anjan Ray, IIT*
3.	*Three Dimensional Equation Chapter 3 Section 1CFD Modelling and Analysis of 500MWe Tangentially Fired Controlled Circulation Steam Generator*	*-G.S.Murthy*	*-Dr. M.R.Ravi, IIT*
4.	*Condition Monitoring for Fault Diagnosis of Coal Mill Gear Box of a Power Station*	*-N.K.P.Reddy*	*-Dr. O.P.Gandhi, IIT*
5.	*Design, Cost Benefit Analysis and Environmental Impact Study of Pumped Storage Schemes attached to TSTPP, NTPC*	*-S.C.Prusty*	*-Dr. P.M.V. Subbarao, IIT*
6.	*Condition Monitoring of Bearings Using Sonic and Ultrasonic Measurements*	*-Ravi Shanker*	*-Dr Sunil Tuli, IIT* *-Sh.Pankaj Bhartiya,NTPC* *-Sh.Anil K.Mittal, NTPC* *-Sh.Ved Prakash, NTPC*
7.	*Effects of Lubricant Rheology in the Inlet Zone of Elastohydrodynamically Lubricated Line Contacts*	*- H.S.Maurya*	*-Dr. R.K.Pandey, IIT*
8.	*Modeling and Simulation of NOx Formation in Coal Fired Steam Generator*	*- C.K.Sharma*	*-Dr.J.P.Subrahmanyam,IIT* *-Dr. Anjan Ray, IIT*
9.	*Studies on Coal Blend Composition for Combustion in an Existing Furnace*	*-M.S.Vishwanathan*	*-Dr. (Mrs.) K.Gadgil, IIT*
10.	*Combustion Characteristic of High Ash Coal in a Pulverised Coal Combustion*	*- B. P. Rath*	*-Dr. Anjan Ray, IIT*
11.	*Simulation of Thermo Chemical Recuperation Combined Cycle*	*- V.Karthikeyan*	*-Dr. P.M.V. Subbarao, IIT*
12.	*Analysis of 16.5 kV/110 V Generator PT Failure at NTPC Dadri from Ferroresonance Point of View Using Analytical Technique and EMTP Simulation*	*-Debasis Rath*	*-Prof. R. Balasubramanian, IIT*
13.	*Simulation of Direct Torque Control of Synchronous Motor*	*-S. Badekar*	*-Dr. G.Bhuvaneshwari, IIT*
14.	*Study of Subsynchronous Oscillations in Series Compensated Lines and Damping Using TCSC*	*-K. Nagesh*	*-Prof. M.L.Kothari*

15.	*Dynamic Simulation of Direct Torque Control of Induction Machine*	*-Rajesh Sharma*	*-Dr. G.Bhuvaneshwari, IIT*
16.	*Analysis and Development of Sensorless Vector Control of Variable Frequency Drive Using Induction Motor*	*-R.S.Saluja*	*-Prof. Bhim Singh, IIT*
17.	*Real Time Performance Estimation of Three Phase Induction Motors*	*- P. B. Venkatesh*	*-Prof. Bhim Singh, IIT*
18.	*Condition Monitoring of Power Transformers (Interpretation of DGA Using ANN, Acoustic Partial Discharge and Frequency Response Analysis (Analytical Study))*	*-A.K.Parhi*	*-Prof. M.L.Kothari, IIT* *-Sh. P.Bhartiya, NTPC* *-Sh. A.K.Mittal, NTPC*
19.	*Application of Power System Stabilizers in Multi Machine System*	*-B.K.Mohanty*	*-Prof. M.L.Kothari, IIT*
20.	*Modeling of Thermal Power Plants and Dynamic Performance Evaluation during Parallel and Islanding Operation*	*-G.S.Agesh*	*-Prof. R. Balasubramanian, IIT*
21.	*Automatic Generation Control in Deregulated Power System*	*-Sushuma Kumari*	*-Prof. M.L. Kothari, IIT*
22.	*Online Estimation of Furnace Exit Gas Temperature (FEGT) Using Neural Network*	*-J.S.Chandok*	*-Dr. I.N.Kar, IIT* *-Dr. Suneet Tuli, IIT*
23.	*Study and Development of Fuzzy Based Expert System for Soot Blowing Optimization in a Large Coal Fired Furnace*	*-P.S.Chowdhury*	*-Dr. P.M.V.Subbarao, IIT* *-Dr. Suneet Tuli, IIT*
24.	*Design and Evaluation of PID, State Variable Controller and Fuzzy Gain Scheduler for Steam Temperature Control*	*-V. Sridhar*	*-Prof. R. Balasubramanian, IIT*

APPENDIX-VI
LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR SIXTH (2003- 2005) BATCH

Sl No.	*Name of Project*	*Student*	*Supervisor (s)*
1.	*Simulation and Analysis of Erosion in Power Plant Steam Generators*	*-V.D.Naik*	*-Dr. P.M.V.Subbarao, IIT*
2.	*Wire & Plate Type Electrostatic Precipitator Modeling*	*-A.K.Singh*	*-Prof. S.R.Kale, IIT*
3.	*Study of Turbine Blade Roughness and its Performance*	*-L.K.Behera*	*-Prof. S.R.Kale, IIT* *-Dr. Lajpat Rai, IIT*
4.	*Flared journal bearing analysis with Asperity and Rheological effects*	*-R.P.Singh*	*-Dr. R.K. Pandey*
5.	*Simulation of Cooling Tower Performance with non uniform water*	*-C.S.Mishra*	*-Dr. Sanjeev Jain*
6.	*Prediction of Heat Rate of a Power Plant and Numerical Simulation of Dust Laden Flow through Orifice for Mass Flow Measurement*	*-R.P.Agrawal*	*-Dr. M.R.Ravi*
7.	*Design of a Gas- to- Gas Heat Exchanger for Microturbine Plants*	*-S.K.Tiwari*	*-Dr. Sanjeev Jain* *-Dr. Lajpat Rai*
8.	*Study of Dust Laden Flows in Ducts*	*-V.R.Mathur*	*- Prof. S. R. Kale* *- Prof. B. Pitchumani*
9.	*Design of Heat Exchanger for the Utilisation of Flue Gas for Air-conditioning*	*-A. Majumdar*	*-Dr. Sanjeev Jain*
10.	*Off-Design Performance Prediction of Steam Turbines*	*-A.K.Mandal*	*-Dr. P.M.V.Subbarao*
11.	*Ash Deposition Studies on Heat Exchanger Tubes*	*-B. Panigrahi*	*-Prof. S.R.Kale*
12	*Development of Predictive Maintenance System for Boiler, Turbine and Generator Using Petrinets.*	*-M.D.Motwani*	*- Prof. R. Balasubramanian* *- Prof. O.P.Gandhi*
13.	*Automatic Generation Control of an Interconnected Hydro-Thermal System in Continuous Mode in both Conventional and Deregulated Environments*	*-M.Parida*	*- Prof. J. Nanda*
14.	*Design, Analysis and Simulation of UN-INTERRUPTED POWER SUPPLY (UPS) With Improved Power Quality*	*-G.N.Rao*	*- Dr. G. Bhuvaneswari*
15.	*Trading Strategies for combined pool and bilateral dispatch in deregulated power market*	*-S.K.Vaish*	*- Prof. R. Balasubramanian*
16.	*Numerical Protection and Fault Location of Series Capacitor Compensated EHV Transmission Lines*	*-R.K.Gupta*	*-Prof. M.L.Kothari*

17.	*Simulation & Analysis of Wound Field Self Controlled Synchronous Motor Drive*	*-Manoj Barsaiyan*	*- Dr. G. Bhuvaneswari*
18..	*Design and Application of Statcom Controllers*	*-J.C.Patra*	*- Prof. M.L.Kothari*
19.	*Automatic Generation Control of a Reheat Thermal System Considering Generation Rate Constraint (GRC)*	*-P.K.Jena*	*-Prof. J Nanda*
20.	*Performance Improvement of Direct Torque Control of Induction Motor*	*-A.P.Satpathy*	*-Dr.G.Bhuvaneswari*
21.	*Optimization of PSS For SMIB and Multi-Machine System Using Genetic Evolutionary Algorithm*	*-Susovan Das*	*- Prof. M.L.Kothari*
22.	*Transient analysis and insulation coordination 765 KV Systems using Alternative Transients Program (ATP -EMTP)*	*-D.Joshi*	*- Prof. R. Balasubramanian*
23.	*Soft Sensing of Turbine Inlet Temperature and Compressor Discharge Pressure of Gas Turbine Power Plant using Artificial Intelligence*	*-Umesh Pareek*	*- Dr. I. N. Kar* *- Prof. R. Balasubramanian*
24.	*Artificial Intelligence (Neural / Genetic Algorithm) based on Line Steam Generator Operation Optimization for 210 MW Power Plant*	*-A.K.Shukla*	*- Dr. I.N. Kar* *- Dr. P.M.V. Subbarao*
25.	*Development of a Methodology to assess effectiveness of maintenance for a power plant using multi-criteria analysis techniques*	*-Rajan Varshney*	*- Prof. O.P.Gandhi*

APPENDIX-VII

LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR SEVENTH (2004- 2006) BATCH

Sl.No.	*Name of project*	*Student*	*Supervisor*
1.	*Evaporative Cooling of Intake Air for Gas Turbines*	*R.Sivakumar*	*Prof.S.R.Kale* *Sh. S.K.Singh, NTPC*
2.	*Mathematical Modeling of Leakage Distribution in Rotary Regenerators*	*Anand Prakash*	*Dr.Sangeeta Kohli* *Dr. Sanjeev Jain* *K.Bhanu Prakash, NTPC*
3.	*Investigation of condition monitoring for extremely slow speed rolling bearings and its extension to air preheater*	*Akhil Agarwal*	*Prof. O.P.Gandhi* *Prof. Naresh Tandon*
4.	*Feasibility Study of Elimination of Low Pressure Steam in Rankine Cycle using Kalina Cycle Technology*	*A.M.Joseph*	*Dr.PMV Subbarao*
5.	*CFD Modeling of Low and Part Load Operation of 110 MW Tangentially Fired Boiler*	*Raj Pal Singh*	*Dr.M.R.Ravi*
6.	*A Numerical study of the Effect of Roughness on Turbine Blade Cascade Performance*	*Harkiran Singh*	*Prof. S.R.Kale* *Dr.Lajpat Rai*
7.	*Analysis of Advanced Gas Turbine Cycles*	*Adibhatla Sairam*	*Dr.PMV Subbarao*
8.	*Failure & Oil and wear debris analysis of primary air fan bearings for maintenance – A Tribological Approach*	*Vinay Kumar Rastogi*	*Prof. O.P.Gandhi*
9.	*CFD Modeling of Primary Air and Coal Flow in a Coal Mill*	*Ratnakar*	*Dr.M.R.Ravi*
10.	*Power Flow Control and Damping of Power Oscillations using Thyristor Controlled Phase Shifting Transforme*	*M.S.Sachan*	*Prof.R.Balasubramanian*
11.	*Modeling and Simulation of a Hybrid Filter for Durgapur Steel Plant Finishing Mill Drive System*	*Subrata De*	*Dr.G.Bhuvaneswari*
12	*Simulation and analysis of load commutated inverter fed synchronous motor drive*	*Anupam Khetarpal*	*Dr.G.Bhuvaneswari*
13	*Modelling of Unified Power Flow Controller (UPFC)in Load flow analysis*	*Krishnendu Goswami*	*Prof. M.L.Kothari*
14	*Design and Study of Nonlinear Controller for Boiler Pressure Control of Natural Circular Boiler*	*D.N.Katyayan*	*Prof.A.N. Jha*
15	*Design and evaluation of model predictive control for main steam temperature Control in pulverized coal fired drum type boiler*	*Sitanshu S.Pati*	*Dr.I.N.Kar*
16	*Efficiency Optimization of Steam Generator of a 500 MW Coal Fired Power Plant using artificial Neural Network*	*Sanjay K.D.Kayasth*	*Dr.I.N.Kar* *Dr.PMV Subbarao*
17	*Assessment of boiler water wall tube thickness by thermography methods*	*U.S.Verma*	*Prof. Suneet Tuli*
18	*Alternate of unit operator with ANN and fuzzy*	*Bheem Rao*	*Dr.I.N.Kar*

APPENDIX-VIII
LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR
FOR EIGHTH (2005-2007) BATCH

Sl No.	*Name of Project*	*Student*	*Supervisor (s)*
1	*Stochastic modeling of short term system mean block frequency in Availability Based Tariff scenario using Artificial neural Network*	*Akhil Kumar Gupta*	*Prof. R. Balasubramanian*
1.	*Modeling and simulation of HVDC system for performance improvement*	*B.C.Mahanta*	*DR.G.Bhuvaneswari*
2.	*Nonlinear modeling of once through coal fired 500 MW boiler for control applications*	*Debabrata Tripathy*	*Prof. R. Balsubramanian* *Dr. P. M. V. Subbarao*
3.	*CFD analysis of shell and tube heat exchanger*	*Dinesh Chandra Gupta*	*Dr. P.M.V.Subbarao*
4.	*3-D CFD Modeling Of Temperature imbalance and NOx emission in a tangentially fired, tower type 500MWe boiler*	*Pravat Ranjan Jena*	*Dr. M.R.Ravi & Mr. V.K. Prabodh*
5.	*Optimization of parameters for Dual input PSS (IEEE type PSS4B)*	*K.V.Rao*	*Prof. M.L.Kothari*
6.	*Study of on-line and off-line washing of gas turbine compressors*	*Narare Balaji B.*	*Dr. S.R. Kale*
7.	*Modeling techniques and simulation of emission (spm) control of coal based thermal power plants*	*Sailendu Nayak*	*Prof. J.P. Subrahmanyam*
8.	*Estimation of Boiler Tube Deposition by Active Thermography*	*S.Awasthi*	*Prof. S.Tuli*
9.	*Very Fast Transients Analysis and Insulation Co-ordination of 400KV Gas Insulated Substation - using PSCAD/EMTDC*	*A.J.Rajkumar*	*Prof. R.Balasubramanian*
10.	*Computation of combined cycle power plant parameters using soft computing tools*	*Raj Kumar Gupta*	*Dr. I. N. Kar*
11.	*On line condition monitoring of Three phase induction motor*	*R.S.Maurya*	*Dr. N. Tandon&* *Dr.G.Bhuvaneswari*
12.	*Model based approach for robust control of power system stability*	*Surojit Sinha*	*Dr. I.N.kar* *Dr. B. K. Panigrahi*
13.	*Prediction of Off-design Performance of Steam Turbines*	*Somnath Bhattacharya*	*Dr. P.M.V. Subbarao*
14.	*Study and Design Of Nonlinear/ Intelligent Controller for Control of Fossil Fuel Fired Power Unit*	*Sunil Kumar Mishra*	*Dr. I.N. Kar*
15.	*Modeling, design, simulation of hybrid filter For power quality improvement*	*Taru Srivastava*	*Dr.G.Bhuvaneswar*
16.	*CFD Modeling of Particle Collection in Wire Plate type Electrostatic Precipitator*	*V.S.Venkatesan*	*Dr. M.R.Ravi*
17.	*Some Aspects of Automatic Generation Control of Hydro-Thermal & Hydro-Hydro Systems*	*Sanjaya Kumar Mishra*	*Prof. J. Nanda* *Dr. S. Mishra*
18.	*Analysis of Wind Driven Induction Generator with Power Electronic Controller to Effect Variable Speed Constant Frequency Operation*	*Shailendra Kumar Tiwari*	*Prof.S.S.Murthy*

19.	Performance study of oil coolers in thermal power plant	K J Rao	Dr.Sanjeev Jain
20.	Automatic generation control in the deregulated power system (Load following control)	K V Vidyanandan	Prof. M L Kothari
21.	Simulation of air flow distribution and performance of cooling tower	Partha Nag	Dr. P M V Subbarao
22.	Experimental and computational investigations of end loss phenomena in turbine steam path	Somnath Bhattacharjee	Prof. S R Kale Dr. Lajpat Rai
23.	Design and techno-economic analysis of a process for solvent extraction of coal-a clean coal technology	Vijay Kumar	Prof. D K Sharma
24.	Orifice sizing for coal flow balancing in a power plant	B R Prasoon	Dr. S Kohli Sh. Shaswattam (NTPC)

APPENDIX-IX

LIST OF PROJECTS WITH NAME OF STUDENT AND SUPERVISOR FOR NINTH (2006-2008) BATCH

Sl No.	*Name of Project*	*Student*	*Supervisor (s)*
1	*Safety Analysis of Boiler and Turbine of Thermal Power Stations*	*Mahesh Prasad*	*Prof. O.P. Gandhi ITMMEC*
2	*Mathematical Modelling of Furnace Draft and Study of its Effect on Boiler Performance*	*Lal Bahadur Sah*	*Dr. P M V Subbarao*
3	*Analysis of Performance and Operation of Steam Generator in Low Oxygen Regime*	*N.N.Sinha*	*Dr. P M V Subbarao*
4	*Parametric Study of 500 MW Pulverized Fuel Fired Boiler Using FLUENT*	*K. Bhanuprakash*	*Dr.M.R.Ravi (IIT Delhi) M.SivaRamaKrishna(NTPC)*
5	*Numerical Analysis of Transient Heat Conduction in Electrical Motors*	*K S R Subudhi*	*Dr. P.M.V.Subbarao*
6	*Analysis of Superheater Temperature Shortfall and Temperature Imbalance in a 500MWe Boiler using CFD*	*P K Behera*	*Dr. M.R.Ravi*
7	*Rankine Cycle Based Power Plant Performance Modeling*	*Sanjay Jain*	*Dr.M.R.Ravi Dr. P.M.V. Subbarao*
8	*CFD Modeling of Heat pipes*	*Rabindra Nath Behera*	*Dr. Sanjeev Jain*
9	*Modeling and Simulation of Airpreheater*	*Niraj Krishna*	*Dr Sanjeev Jain*
10	*Power Quality Improvement in Variable Frequency Drive using Hybrid Filters*	*G.K. Mehndiratta*	*Dr.G.Bhuvaneswari*
11	*Congestion Management in Restructured Power Systems*	*N.N.M.Rao*	*Dr.B.K.Panigrahi*
12	*Phaselet Based Distance Relaying Algorithm*	*S.P.S.Pundir*	*Prof M.L.Kothari*
13	*Analysis of Wind Turbine Driven Doubly Fed Induction Generator*	*Navin Kishore*	
14	*Analysis of Rihand-Dadri HVDC System*	*F.Rahman*	*Dr.G.Bhuvaneswari*
15	*Wavelet Transform Technique for Differential Protection of Transformer in the Perspective of NTPC Unchahar*	*Anand Kumar Jha*	*Prof. R. Balasubramanian Dr. B.K.Panigarahi*
16	*Facts Devices Modelling & Control to Improve the Power System Performance*	*S.S.Bhadoriya*	*Dr.B.K.Panigrahi*
17	*Analysis of SSR Phenomenon and Protection of Generator against SSR*	*Ram Krishna Niranjan*	*Prof. R. Balasubramanian Shri R.K.Bhatnagar*

18	*Developing Fault Locating Algorithm for a Series Compensated Transmission Line*	*Mohit Atrey*	*Prof. M.L. Kothari*
19	*Online Condition Monitoring of Electric Drives Using ESA*	*Lalit Grover*	*Prof. S.S.Murthy* *Dr. G. Bhuvaneshwari*
20	*A Numerical Method for Determination of Defect Shape from Magnetic Field Measurement*	*R. Meganathan*	*Dr. M. Nabi*
21	*Void Fraction Measurement Sensor for Thermal Power plant Boiler Application*	*Binay Jose*	*Prof.S. Tuli*
22	*Defect Shape Construction for NDT using Eddy Currents*	*Dibyendu Guha*	*Dr. M. Nabi*
23	*Design and testing of Model predictive controller for main steam temperature control in coal fired power plants for a drum type boiler -comparison of ANN MPC and Physical principle MPC*	*M.Karikalchozhan*	*Dr. S. Janardhanan*
24	*Efficiency Estimation of Decision Making Units with Imprecise Data using Fuzzy DEA approach*	*S K Behera*	*Dr.I.N KAR*