ABSTRACTS

M. V. Bazylevych, P.M. Baran, V. P. Kidyba, G. M. Lysiak, I. O. Sabadash

A PHYSICAL MODEL OF THE TELEAUTOMATICS SYSTEM FOR OPERATIVELY-CONTROLLER'S MANAGEMENT SUBSTATIONS

The article deals with the functions and capabilities of the upgraded protective "Altra" device .It is necessary to obtain information about the condition of contact devices in addition to voltage and current information to control the substation work. For this purpose the serial "Altra" device has a binary inputs block, which signals about the condition of the contact system. The substation control equipment is provided through the "Altra" device output relays.

The description of the secondary switch circles physical model imitated the typical double-transformer substation is given (control and alarm switch circles). The switches are made with the contactors. Each switch has "on" and "off" modes which are formed by the special relay commands created on the basis of RP-23 type intermediate relay. The special indicated lamps identical to those used at the substation shows the mode of each switch. The scheme of connection between the "Altra" device and voltage circles, current circuits and control circuits and indicated switches is included into the article. The model reproduces remote control switches substations using standard communication channels and information about the state of the switch on the control point. All model equipment is placed on the special stand.

The automatic work unit is based on the substation control room PC. The communication between the "Altra" device and the substation control room PC provides by using wired networks such as Ethernet and wireless networks such as GSM. The example shows the equipment condition equal to the data on the work unit PC.

The calculation of currents and voltages values of each accession, active and reactive power, power factor of each connection is given. All values are calculated based on the instantaneous values of phase voltages tire plants and phase currents connections.

The article deals with the possibility of making operational dispatch management system using relaying.

Y. O. Biletskyi, R. O. Biletskyi

ENERGY-SHAPING CONTROL OF NONLINEAR SYSTEMS WITH TWO-ZONE DIRECT-CURRENT ELECTRIC DRIVE

In recent years the rapid development of new approaches to the synthesis of control systems for nonlinear systems, including electromechanical (EMS), has begun. Among them stands out energy approaches, especially those that are based on Hamiltonian representation. Their development requires a deep understanding of the physical processes that occur in control objects, but they are simple to implement and establish.

These approaches only begin to find application in EMS. Having powerful synthesis algorithm precisely for nonlinear systems, electric drives to which control they were applied, were considered as the most-simplified objects. They do not take into account such important phenomena as iron loss, the presence of the magnetization curve, nonlinearities, that occur when changing the flux, dry friction and others. Forming correct model and proper transformation to Lagrangian or Hamiltonian systems form are among the most important steps in control systems synthesis in energy-based approaches. Therefore, this simplification not only doesn’t disclose the potential use of energy-based approaches, but also resulted in low static and dynamic performance of received systems and led to the necessity to combine energy-based approaches with other approaches. On the other hand, taking into account all nonlinearities in the model of complex EMS leads to complexity in synthesis procedure and final equations of regulators.

There are proposed two approaches to the synthesis for energy shaping control system (ESCS) for such system based on its simplified model, namely: first - synthesis of adapting corrector, that will carry correction of regulators output signal; second – forming task signal for the system, that will take into account the non-

linearity. According to these approaches it was obtained ESCSs for direct motor with two-zone speed regulation, non-linearity of the magnetization curve and variable time constant of the field loop. Research has shown that both approaches allow you to get ESCS with high static and dynamic performance, and the presence of mechanical damping provides linear dynamics. The correction task signal does not only maintain the desired properties of Hamiltonian systems, but also provides a slightly higher performance.

Y. Varetsky, O. Pastuh, V. Horban

CONCERNS OF OPERATING COMPENSATION DEVICES IN MINE ELECTRIC GRIDS

Reactive power compensation equipment in industrial electric power supply systems generally operates in environment of significant harmonic distortion currents, which are caused by presence of nonlinear loads. Most of powerful industrial enterprises need compensating time variable reactive power. Use of capacitors in such circumstances is a traditional cheapest solution. Harmonics generated by nonlinear loads in power supply systems of the enterprises greatly complicate reactive power compensation, because installing capacitors can provoke magnification of some harmonic currents. This is due to such concerns of the compensation system operation as capacitors overloading and increasing voltage distortion in the electric grid over the standard norms.

In the mining industry the most powerful non-linear loads are electric DC drives. A common practice in such supply systems is the use of compensation schemes, which consist of a combination of filters and capacitor banks. Under selecting the filter design appropriate impedance values of its capacitor bank and reactor should be provided. Typically, these values have some deviation from designed values, due to manufacturing features of capacitors and reactors. For complex reactive power compensation systems with multiple power filters this circumstance may have a significant impact on the electric grid operation.

The paper presents study of operation conditions such compensation scheme in the power grid supplying coal mine. Features of parallel operation of the filters with the same tuning have been studied and it was shows the need of considering manufacturing tolerances of the filter capacitors and reactors in the analysis of their loading. Case study of a operating mine power supply system has shown the possibility of unacceptable filters overloading in the described reactive power compensation system. Therefore, selecting the design of reactive power compensation for industrial power supply systems with nonlinear loads should consider these factors.

V. G. Gapanovych, Z. M. Bakhor

CALCULATION METHOD FOR AMPLIFICATION RATES OF A REGULATOR OF A STATIC THYRISTOR COMPENSATION UNIT

In the power supply networks feeding significantly variable loads, which includes mining networks, the general factor influencing work mode of electrical equipment is deviation and fluctuation of mains voltage. In order to compensate abovementioned consequences it is proposed to develop Static Thyristor Compensation Unit (STCU) on the basis of the existing Battery of Static Condensators (BSC) of the substation. Installation of an additional group of thyristors and reactors is proposed. As a result the mentioned STCU should be integrated with the On-load Voltage Regulation (OLVR) device thus creating a complex control system of power supply of mining load. A regular regulation system of the series reactive load thyristor compensation unit built on the disconnected principle of regulation is not effective during the voltage stabilization in the STCU joint, because it doesn't count influence of the changes of the voltage mode of the Main Electric Energy System (MEES) onto the substation's busbars voltage.

There were calculation method for amplification rates by voltage and current of a proportional action regulation unit of the STCU developed by the authors. A particular instance of the calculation by the method is

based on the battery of static condensators 31MVA 35kV and thyristor compensation unit TKPM-20/6 (20 MVA, 6 kV), which allows to tune STCU for the voltage stabilization in the joint with high level of precision.

Y. Hrytsiuk, V. Konoval, V. Moroz

THE IMPACT ANALYSIS OF THE TYPE EXCITATION SYSTEM OF OFFLINE SYNCHRONOUS GENERATOR ON HIS TRANSIENT RESPONSE

The analysis using automatic control theory provided for IEEE classification of the excitation systems of synchronous generators. To analyze the stability offline synchronous generators with the excitation system used the automatic control theory method by simplifying their structure models, because some system parameters are unknown. Such simplified models are suitable for real mode frequency deviation within 5% of the nominal value, and they based on the Park's equations. Using a full Park's mathematical model for practical calculations not used because some of parameters of power system are unknown and can be obtained only by special experimental studies of synchronous machines.

The mathematical description of differential equations with appropriate RL-branch as simulated load elevated to the block diagram model that simplified using automatic control theory with regard to active and reactive components of the electrical load and analyzed in MATLAB + Simulink environment using Control System Toolbox. The resulting structural model supplemented transfer function corresponding excitation systems with controllers as recommended by IEEE.

Analysis of the results shows that the systems DC4A, AC1A, AC7B, ST1A and ST5B provide the best behavior and the least time overshoot. For more information on the impact of these excitation systems on stability and its supply to the electric power system obtained using the methods of automatic control theory, in particular, by analyzing the placement of zeros / poles in the complex plane for each of exciter's systems.

Analysis of the research showed that among the current regulation of synchronous generators excitation current best opportunities to implement laws and stock stability control provide advanced system PI- and PID controllers.

Confirmed that the current excitation systems used PI- or PID-controllers with better performance and simpler in terms of the desired stability of power systems. Studies have shown that the best industrial system excitation due to the stability and ease of setup are systems like DC4A, AC1A, ST1A and ST5B under IEEE classification.

B. V. Dmytryk, O. M. Ravlyk, I. O Sabadash, N. O. Ravlyk

THE INFLUENCE OF ON-LOAD TAP-CHANGING DEVICE ON THE IDENTIFICATION OF WINDING SHORT CIRCUITS IN POWER TRANSFORMER

The identification of winding short circuits is based on the permanent analysis of active resistance of windings in power transformer. The algorithm of this protection is based on the abrupt change of the resistance of winding, which is the main feature emergency mode. During the winding short circuit the change of the complex resistance and mainly its active part happens, which means that the transformation factor changes as well.

The same situation appears when the on-load tap-changing device is switching. The main feature of this device is that it changes the number of winds in during the operation of transformer. During the analysis of the results of investigation there was revealed that the operation of on-load tap-changing device is very similar to the winding short circuit, since the resulting active resistance changes significantly. On-load tap-changing device allows us to regulate the number of winds in the following limits: ±16%.

In order to solve the problem of using this device, the simulation model of power transformer was updated with the respective simulation on-load tap-changing device that allows to regulate transforming factor. The process of switching in this device can be divided into two steps. The first one is based on the switching of one of two contactors from one point to another. During this operation the in winding current is limited by the respective reactor to the nominal values. The second stage is based on the switching second contactor, but vise-versa which signals of the end of on-load tap-changing device switching. While increasing the number of winds of primary winding, the identification parameter increases and during the decreasing the number of winds, it goes to negative values. Thus, the algorithm of identification winding short circuits must consider the information from on-load tap-changing device in order to update the transformation factor respectively. This includes the direction of the action of the device and its position. It will allow to taktoe in account the actions from on-load tap-changing device during the operation of power transformer in order to be sure that short circuit occurred. Thus, the selectivity and reliability of the defense increase.

The following conclusions were made: during the increasing of the number of winds, the update of transformation factor should be performed after switching; during the decreasing of the number of winds, the update of transformation factor should be performed on the beginning of switching.

A. Kutsyk, M. Semeniuk, A. Yevchenko, T. Dzioba

ANALYSIS BY MATHEMATICAL MODELING OF TRANSIENT PROCESS IN THE POWER GENERATION SYSTEM BY TURBO-GENERATOR WITH BRUSHLESS EXCITATION SYSTEM

The transient electromagnetic and electromechanical processes in power generation system by turbo-generator with brushless excitation system for basic operating modes, such as an initial excitation of generator, voltage regulation on no-load, connecting into power line, loading of generator by active and reactive power are analyzed in the article.

The research has been carried out by the example of the real power generation system of South-Ukrainian Nuclear Power Plant. The power generation system consists of three parallel working turbo-generators of 1000 MW. The excitation system of turbo-generators includes a brushless exciter. The excitation regulator of strong action has been used as an automatic excitation regulator.

Analysis of transient electromagnetic and electromechanical processes in the power generation system by turbo-generator with brushless excitation system has been carried out using developed mathematical and computer models that are based on object-oriented methods and take into account the non-linearity of synchronous machines and the discretion of semiconductor converters, asymmetries and mutual influences between all components, the possibility of interaction of model with real physical equipment through analog and discrete signals. The models have been created by use of the one-step numerical method of average voltages on an integration step.

The results of the research have shown that the brushless excitation system of generator with automatic excitation control of strong action provides high quality transient modes in the main working regimes of generator. In particular, the maximum dynamic error of voltage that occurs, when voltage decreases on 5%, is 3.9% and the static error - 0.7%. It should be noted that the presence of auxiliary electrical machine - brushless exciter in channel of generator excitation current regulation slows down the speed of action of excitation current regulation in comparison with static excitation systems.

The carried out analysis of transient electromagnetic and electromechanical processes in the power generation system by turbo-generator with brushless excitation system in the main working regimes of generator has a practical value for the synthesis of excitation systems of turbo-generators.

O. Yu. Lozynskyy, Ya. S.Paranchuk, V. B. Tsyapa

MATHEMATICAL DESCRIPTION OF THE ARC STEEL-MELTING FURNACE ELECTRODES POSITIONING CONTROL SYSTEM DYNAMICS USING STATE-SPACE MODEL

A new methodological approach has been worked out to describe the processes of the electric and mechanical coordinates changes for the typical controller of the arc power – the automatic control system (ACS) of an arc steel-melting furnace (ASF) electrodes position in the form of state variables and the basis of matrix-vector differential equations. Compared with the known methods, the proposed one is convenient for computer analysis of the power supply circuit electric mode coordinates change dynamics in the three-phase AC arc system and allows to solve both the problems of analysis and the dynamics synthesis in the time domain. The mentioned system of arcs power control is considered as a nonlinear non-stationary multidimensional three-phase interconnected electromechanical system.

A structural diagram of the electric furnace arcs length adjusting system, which is adapted to the description of the modes in specified mathematical basis and implements impedance (differential) law of the electrodes movement control signal is proposed.

Obtained mathematical model is based on the classic matrix-vector equation $\dot{X}(t) = A \cdot X(t) + D \cdot W(t)$ where $W(t)$ is the vector of state variables, $\mathbf{U}(t)$ – vector of control signals, $W(t)$ – vector of external influence signals, **A** – matrix of system coefficients, **B** – matrix of controls, **D** – matrix of external influences and disturbances.

In the composed structure and model specific feedback is taken into account, due to the mentioned complex control object – the arc space, and on input of the electrodes movement system control signal is formed based on the electric mode error signal, causing electrodes movement.

In the considered structure of the arc lengths ACS, in addition to the "object" feedback, a control signal Uc is formed as a set of feedbacks by to the coordinates of the state variables vector X(t), namely, by the speed of the engine, as the first derivative of the displacement, the current of the engine rotor, the second derivative of the displacement, and also by the thyristor converter voltage, used in the considered typical ARDM-T arc power controller.

The purpose of the proposed structural solution is the control system implementation and its optimal control model, that meets the minimum quadratic integral criterion and is obtained by solving algebraic Riccati equation for the current stationary interval of perturbations, which present in the three-phase power circuit and arc melting space.

***N. H. Maltseva, **M. Yo. Oliynyk, V. H. Fedyshyn**

PERATION ANALYSIS OF THREE-PHASE UNCONTROLLED BRIDGE RECTIFIER ON CONDITION OF CORRECT REMOVAL OF TWO AND THREE GATES FROM ITS CIRCUIT

A three-phase bridge rectifier can function when one, two, three and four gates are correctly removed from its circuit. The removal of a certain number of gates from the circuit of the three-phase bridge rectifier can be used to discretely adjust the average value of rectified voltage; at the same time such modes appear as abnormal when fuse blocks in the valve arm blow out. Correspondingly, there is a need to study the operation of the newly created circuits in order to assess the possibility of their practical application or to assess the influence of abnormal modes of a three-phase bridge rectifier circuit on the functioning of converter equipment devices, where the rectifier is used as a constant voltage source. Such circuits are partially researched in [1] under purely active load resistance. The changing load nature of the direct current circuit causes some interesting phenomena which have not been researched yet. In the present article the authors research the newly created rectifiers after removing two and three gates from the circuit of a three-phase bridge rectifier.

When researching the circuit with two removed gates of different shoulders and groups it was established that under the active or active-inductive nature of load, the waveform of rectified voltage is

unchanged and has zero value of duration T =π/3. This is due to the bypass mode of direct current circuit. The discharge of energy accumulated in the inductance occurs through the gates of the intact gates shoulder.

On the contrary, for the circuit with three removed gates the waveform of rectified voltage depends on the nature of load. Here, there is no bypass mode, the energy accumulated in the load inductance keeps the gates in the conducting state, which leads to the appearance of negative values of rectified voltage and a decrease in its average value. Under certain inductance value, rectified current becomes continuous, and rectified voltage acquires the smallest value.

Analytical expressions for calculating the average value of rectified voltage without regard to switching losses and taking them into consideration are provided.

Rectified voltage curves are expanded in Fourier series which helped to discover their harmonic composition. The value of the first eighteen coefficients of the Fourier series are provided in the work.

Each of the considered modes is illustrated by flow diagrams of currents and voltages, which facilitates understanding the processes in the newly created rectification circuit.

V. O. Misurenko, M. B. Semeniuk

ANALYSIS OF THE AUTOMATIC LEVEL CONTROL BY USE OF FREQUENCY-CONTROLLED ELECTRIC DRIVE OF PUMP UNIT

The analysis of the system of automatic control of liquid level in the tank by use of frequency-controlled asynchronous electric pump unit has been done in this article. The expediency and conditions of P- and PI-regulator use have been justified.

The reservoir, which is being considered in the article, is an integral element, so to solve the problem of stabilization of liquid level is possible only by use of a closed system of automatic control of the level feedback.

There has been developed a mathematical model of system of level control for resolving the task of the synthesis of level regulator. The model takes into account the following features of the frequency invertor: limiting the output signal of the regulator, limiting output current of the frequency invertor and, as a the result, physical limitations of acceleration / deceleration of the speed of the pump.

The article by analytical and mathematical modeling has proved that the system of automatic control of the use of P-regulator is the astatic system by reference and static system by disturbing action. It is necessary to enter a regulator integral action to eliminate static error of the system from disturbing action, namely, it is necessary to use PI regulator.

The results of the research of automatic level system, made by Matlab Simulink, have shown that in terms of dynamics (system stability, low sensitivity to variations in system parameters, no overshoot) preference should be given to P regulator. The increase in the gain of regulator reduces the static error and the time of transitional process. However, in the case of the substantial increase in this ratio, there is a threat of fluctuations in the transition process and even the appearance of fluctuations due to the effect of small steady time, which have been omitted in this research.

The limit of the output signal of regulator, using which was conditioned by the physical properties of the frequency converter and pump unit, causes a significant deterioration in the quality of the transition process. This is explained by the fact of saturation of the integrator part of regulator. As long as the modern frequency invertors do not have a possibility to adjust the structure of regulator with the aim to minimize the impact of limiting the output signal of the regulator on the quality of the transition process, therefore, to improve the transition process, it is reasonable to use a sequential search of certain correlation between proportional and integral components of the regulator during commissioning work.

K. Pokrovskyi, O. Mavrin, J. Sheleh

CHOICE OF POWERFUL WIND TURBINE FOR REAL CONDITIONS

In paper are represented the calculation performance of wind power generators vary in capacity from one manufacturer in the real conditions of Ukraine Karpatian region. Choose different from one manufacturer of generators allows for comparison of the characteristics more correctly. One of the problems of wind energy is determined insufficient information available about the effectiveness of wind farms in the real conditions, due in particular to commercial issues of use.

To increase the growth rate of wind power should provide a broad introduction of simplified and low-cost methods for assessing the economic efficiency of wind turbines and wind farms. The results of this method are in paper show. When using the wind turbine parameters can calculate the necessary preliminary analysis of the economic efficiency of wind power options - annual electricity production, income, payback period.

The obtained characteristics allow approximately estimate the investment, expenditure and profitable components of the project at the stage of pre-project work.

In this paper presents the calculation of performance three options imaginary 10-units power stations ENERCON wind turbines with a capacity of 3,5 MW, 4,2 MW та 7,58 MW per unit. To calculate the parameters of power used data confirmed annual wind loads one of the promising areas of the Ukrainian Carpathian region. The calculations used actual wind load selected industrial areas of Ukrainian Karpaty, that confirmed preliminary estimates and compared with the results that have been tested in real conditions. This gives more weight for the results. Analytical made cost estimates for wind turbines and their installation and operation, profit margins and estimated payback period for options of power stations.

It is shown here the high efficiency of the implementation of wind power in terms of the Carpathian region. Calculated data make it possible to compare different wind turbines from one manufacturer to select the best option. It is shown that wind turbine power 4,2MW provides the least payback period of investment. But maximum annual income shows the largest power generator.

V. I. Chibelis, V. U. Lobodzinskiy

ANALYSIS OF METHODS FOR CALCULATING ELECTROMAGNETIC TRANSIENTS IN MULTIPHASE TRANSMISSION LINES WITH DISTRIBUTED PARAMETERS TYPE OF HIGH VOLTAGE CABLE LINES

Mathematical modeling of three-phase cable lines in phase coordinates is carried out using the theory of multiterminal networks or groups of single-phase cables. Modeling complicates by the need to incorporate magnetic coupling of phase circuits. In the development of some models methods of analysis and synthesis of RLC are used – single-phase equivalent circuit elements and method of differential equations for transient processes analysis in nonlinear and stochastic changes in electrical resistance load. Where applicable to analyze the perturbed electromagnetic processes it is expedient to use numerical methods implemented in application packages.

The main purpose of this work is to develop methods for calculating multiphase transmission lines with distributed parameters such as high voltage cable lines for the analysis of electromagnetic and transient processes in three-phase cable lines by creating new and improving existing mathematical models and macromodels of their elements, suitable for emerging in them fixed and transitional electromagnetic processes.

Calculation carried out for the three-phase cable line. The cables are located on the delta with the distances between the centers of living equal to the outer diameter of the cable. Cable shield is grounded on both sides and to limit stress on the shields of the cable shields transposition cable.

We apply the method of simulation of the phase coordinates for cable power lines, which is a natural representation of the three-phase system. The difficulties with this method associated with the presence of mutual inductance effects between live parts of different cables phases. For the circuit been synthesized the equal 12-terminal circuit.

The settlement scheme, which is regarded as single-circuit line is implemented by using an application package Simulink in Matlab system.

Based on this approach, the model obtained in phase coordinates three-phase cable line systems and single-shielded cables, placed in Earth and aerial systems designs.

The models provide effective solutions to the problem of modeling any practical modes of high-voltage cable power lines in phase coordinates.

I. Shchur, V. Koziy, P. Holubovskyy

BRUSHLESS DC ELECTRIC DRIVE BASED ON INDUCTIVE-CAPACITIVE CONVERTER

For electric drives powered from industrial networks, electromagnetic compatibility (EMC) is an important factor, which can be represented by such indicators as the Total Harmonic Distortion (THD) and cosφ. To improve EMC and simultaneously simplifying the control system, the electric drive system "controlled current source – BLDC motor" is developed in this paper. Current source (CS) is created on the base of the parametric inductive-capacitive converter (ICC), which is powered from industrial network. The diode bridge rectifies output current of the ICC. To control the value of direct current, the circuit with one IGBT-transistor, which shunts output current of the ICC, is applied. A simple thyristor current-source inverter with interfacial switching, which are controlled by the signals of the three-point rotor position sensor realized by the Hall sensors, provides power switching of the armature windings of the motor with permanent magnets (PM).

For computer modeling and simulation studies, the PM motor at rated power of 30 kW, which achieved at nominal angular speed of 1500 rpm was selected. Speed control of motor carry out in a two-loop control system with the external speed control loop and the internal CS current control loop. Research work of the proposed system carried out on the computer model, created in the Matlab/Simulink environment. A two series of computer experiments were carried out. In the first series, we studied EMC performance of the system – THD and factors of the 5, 7, 11, and 13 harmonics. Studies have shown that the introduction in ICC current regulation has led to a significant increase of current harmonic consumption. To reduce them, it is useful to introduce an additional grid passive filter. In the second series of experiments, we investigated the work of created drive system. The experimental results have showed a high dynamics of the drive with such simple structure of the control system.

Thus, developed BLDC drive system based on parametric ICC controlled by one IGBT-transistor features by simplicity and reliability of the design.

M. A. Yatsyn

VECTOR POTENTIAL OF THE MAGNETIC FIELD OF AN OVERHEAD RING EDDY CURRENT CONVERTER WITH CONDUCTIVE FERROMAGNETIC CORE

For the increase of sensitiveness of eddy current of primary transducer his puttee of excitation is placed on П-image ferromagnetic to the core. A presence over a core brings also to the concentration of magnetic-field and, the same, substantially promotes control locality. Therefore actual is research of magnetic-field of puttee of excitation of eddy current converter (transducer) with ferromagnetic core. In this case with the sufficient measure of exactness the calculation model of magnetic-field can be presented with the reserved superconductorial screen, because the magnetic field is reflected from horizontal part (yoke) core, parallel to the surface of control object, and symmetric in relation to an axis between vertical parts core. Then the height of screen above the surface of control object is equal to the height of vertical parts (bars) core, and radial size of screen - to the half of distance between their axes.

Vectorial potentials in all areas are determined by means of fictitious currents after certain calculation models with a homogeneous environment. At the calculation of magnetic-field in any area fictitious (to the calculation) currents be placed only in all other areas, because they must answer homogeneous equalization for vectorial potentials of the prospected area. Therefore in basis of construction of calculation models next positions are accepted:

1. A model for the calculation of magnetic-field in any area embraces the same space, that and the real model with a heterogeneous(multi-layered) environment, and differs from the last absence(in all calculation models, except a model for an area with the puttee of excitation) of the real and presence of fictitious currents with a permanent closeness within the limits of every contiguous nearby area, and also by homogeneity of environment in all space with properties of that area the magnetic field is investigated in that.

2. The magnetic field in area of puttee of excitation is created by the real current of excitation in this area and calculation currents with a permanent closeness within the limits of every contiguous nearby area in a homogeneous environment with properties of area with the puttee of excitation.

A. V. Chaban, V. R. Levoniuk

ANALYSIS OF TRANSIENTS IN TRANSMISSION LINES THAT CONNECT SUBSTATION «ZAKHIDNOUKRAYINS'KA» AND SUBSTATION «VINNYTS'KA»

In the work proposed for modeling transients in the electrical grid of 750 kV electricity system using the principle of a modified Hamilton-Ostrogradskii. The mentioned approach makes it possible to avoid decomposition a common dynamic system that allows you to consider some veiled covert motion. This is important for systems with distributed parameters, which we review the present work.

On the basis of our the developed new interdisciplinary method of mathematical modeling of dynamic systems, based on the principle of modified Hamilton-known Ostrogradskii and expansion of the last non-conservative dissipative system, the mathematical model of the electrical network of 750 kV electricity system. The model makes it possible to analyze transient electromagnetic processes in all elements of the system.

In this work the model used to study transients during the short circuit 3-phase at the substation "Vinnitsa" on the side of 330 kV. Analyzing the results can be seen that our proposed approach and developed based on this mathematical model is adequate confirming physical principles regarding electrodynamics of wave processes in long power lines. Presented in 3D format, time-space distribution function of current and voltage provides the most information about wave processes in a long line with distributed parameters.

The originality of the article is that the method of finding the boundary conditions of third kind (provided Poincaré) in accordance with all state of electric differential equations system, to find the boundary conditions at the beginning and end of the line involves all state equations object. This approach enables the analysis of any state system. In the present work an example used state of the line when exiting the system at steady state and three-phase short circuit on the side of 330 kV.

Practical application is that the wave processes in lines affect different kinds of electrical devices, proper investigation of wave processes and their interaction with other processes in the cell is the theme of the present work.

I. R. Holovach, L. F. Karplyuk, B. Y. Sylvestruk

THE ISSUE OF PROTECTING THE MAIN DRIVE OF THE DIFFUSION APPARATUS DDS-30 (DS-12)

The article describes main elements and types of protection for the main drive of the diffusion apparatus DDS 30. As a technological sensor for the extraction process of sugar from beets in the diffusion apparatus, a change in the magnitude of the load of the main drive was used, and the transport screws are considered as an integral sensor of the state of the juicer mixture in the apparatus trough.

The following protections are provided in the circuits of the electric motor: protection against short circuits in electric motors and thyristor controller; protection of limitations of maximum currents of the electric drive; protection of the formation of the working characteristics when starting and dispersing the diffusion apparatus; protection of limitations of maximum currents of electric drives overload (thermal protection); protection (limitation) of the maximum rectified voltage at the output of the power regulator. For the above protection, the calculation method and the order of their adjustment are given.

To prevent a crash that causes the rolling of the shafts, the extractors are equipped with devices to synchronize the work of these shafts, which use the definition of potential difference and overvoltage protection. The differential protection function covers the entire complex of the diffusion apparatus: electric drive, mechanical transmissions, transport screws, flow of technological process.

The proposed upgraded differential protection scheme will not only simplify the process of debugging, but also, the most important, using the differential indicator, to control the drive of the diffusion apparatus during operation, especially its mechanical part. With the help of the differential indicator you can identify problems in the work of gears and transport screws, which, in turn, depend on mechanical, technological or electromechanical reasons.

Given analysis of main protections of the diffusion apparatus main drive has practical value at the time of their determination and provision of the effective and safe operation of the entire diffusion department of the sugar plant.

O. Hamola, V. Korud, S. Rendzinyak

USE OF PROBLEM-BASED LEARNING WHILE STUDYING ELECTRICAL ENGINEERING

The issues complex laboratory work performance with electrical courses on the principles of problem-based learning was described in this article. Problem-based learning is relevant at this stage of obtaining knowledge, due to the active introduction of interactive training programs. The article shows the possibility of using problem-based learning in the study of electrical devices in the laboratory course with the theory of electrical circuits in computerized laboratory-based training systems Laboratory Virtual Instrument Engineering and OrCAD. The special feature of this approach is a hybrid form of laboratory work that requires physical experiments and computer simulation. Student connect up scheme, learns about measuring current, voltage, using modern means of measurement based on analog-digital conversion with visualization on the computer screen during a physical experiment. Virtual experiment introduces students with the mathematical description of the research object, makes it possible to check the quantitative results of both experiments, to analyze the reasons for their differences, which is very important in the study of technical subjects. In addition, computer simulation allows to implement technology problem-based learning, the essence of which is the formation during of a learning process problematic situations, and solving this problems by the students. Problem-base learning changes the motivation of cognitive activity, leading are cognitive-incentive motives. Due solve of the problematic situation arises interest in learning, which intensified during mental work associated with searching for and finding solutions of the problematic task or set of tasks. On this basis arise an internal interest that turns into a factor of activization of educational process and learning efficiency. The essence of the methodical approach to build such the structure laboratory work and the role of teaching the subject shown in this article. The example of such an implementation of laboratory work, which clearly confirms the appropriateness of the proposed approach to perform laboratory work on the theory of electrical circuits is shown.

A. Kryzhanivsky's

HERE IS THE SUMMARY OF ANDREI KRYZHANIVSKY'S ARTICLE "THE CONTRIBUTIONS OF PROFESSORS AND TEACHERS OF LVIV POLYTECHNIC UNIVERSITY TO THE DEVELOPMENT OF ELECTRIFICATION OF THE LVIV REGION."

The beginning of electrification of the Lviv Region coincides with the opening of the Electrical Engineering Department of in the Lviv Polytechnic National University in 1891. This resulted in establishingthe Lviv Electrical School - a combination of science with practical work.

The first ever power station in the Lviv Region was built in Lviv back in 1894 for the city electric tram,on the proposal of R. Dzeslyevsky, the Department Head and later Rector.

Soon its capacities ceased to be enough, and in 1909 R. Dzeslyevsky'snew idea was implemented – a power stationwas constructed on the street Kozelnytska, which exists up to the present day. Once it started operating, the first power plant was closed down.

The Lviv power plant became a source of electricity for other cities. The project of power grids was developed by prof. G. Sokolnitsky, who was the Rector at the Lviv Polytechnic National University in 1931-1932. According to his project, the state program on constructing a 30 kV network from Lviv to Zhovkva, Yavorov, Rava-Ruska, Pustomyty, Gorodok, Vynnyky was approved, which led to shutting down local unprofitable power plants.

M. Altenberg, an associate professor of the Lviv Polytechnic National University, became took charge of the newly established Electro-Lighting Institution of the Lviv Region.

Sokolnitsky and Altenberg supported the idea of constructing power plants exploiting energy resources like oil, gas, coal or water deposits, rather than constructing small local power stations in cities. Back in 1917, they sought to build a powerful power plant using associated gases obtained from oil wells in Borislav, which would simultaneously solve the problem of gas pollution in the city of Borislav. Their project was implemented in 1922, and by 1931, it turned to bethe main power plant supplying electricity to Drohobych, Stryi, Sambir, Truskavets and other cities.

The posts of practicing professors at the Lviv Polytechnic National University were taken by Z. Stanetsky, a battery factoryowner, and S. Frieze, whose project was equipped with a system of special effects in the Lviv Opera House.

Engineers understood the benefits of cooperation with the production sector; the refore, they invited directors of the Lviv City Electric Museums M. Dzevonsky and S. Kozlovsky to read a series of lectures on servicing power plants and networks.

M. A. Yatsyn

EQUATION OF DENSITY OF CALCULATION CURRENTS OF VECTOR POTENTIAL OF THE MAGNETIC FIELD OF AN OVERHEAD RING EDDY CURRENT CONVERTER WITH CONDUCTIVE FERROMAGNETIC CORE

The Calculation currents allow to define vector potentials in all areas of calculation model of superimposed screened circular primary converter with conductive ferromagnetic core above a conductive ferromagnetic plate. The chosen calculation model consists of six areas and then vector potentials in them are determined by means of the system from 14 equalizations for determination of density of all calculation currents.

At the calculation of vector potential of magnetic field in any area calculation (fictitious) currents be placed only in nearby areas, because they must answer homogeneous equalization for vector potential of the investigated area.

Calculation currents are accepted with a permanent closeness within the limits of every contiguous nearby area and operate in all space of homogeneous environment with properties of that area the magnetic field is investigated in that.