

**Annotations of the scientific works  
of Associate Professor, PhD, MEng Rumen Kostadinov Popov  
Department of Electronics, Telecommunications and Information Technologies**

▪ **PhD Thesis**

**Popov, R.K.** Reconstruction and modernization of existing systems for backup power supply of agricultural holdings. Dissertation for awarding educational and scientific degree "DOCTOR" Ruse, 2008. COBISS.BG-ID – 1248091620;

<https://plus.bg.cobiss.net/opac7/bib/1248091620>.

*The dissertation is discussed and directed for defense at the SNA in agricultural and forestry equipment at the Higher Attestation Commission by a joint scientific unit formed by specialists from the departments "Internal Combustion Engines", "Automation and Information Control Equipment" and "Cars, Tractors and Trucks" in Angel Kanchev University of Ruse on June 11, 2008.*

*The developed methodology for identification of static and dynamic parameters of diesel fuel equipment in operating units can be applied in various necessary studies in the field of control systems for diesel engines and electric units using simulation modeling;*

*The compiled hierarchical system of mathematical models describing the joint compatible operation of the subsystems of diesel power units can be used both in the reconstruction of adjacent and in the synthesis of new control systems for DEA, which use them in different modes of operation (start-up, normal operation with different loads, stopping, short circuit, connection in parallel);*

*Application of a loop with phase auto-tuning of frequency (FADC) in systems for stabilization of speed of rotation of diesel electric units (DEA), providing zero phase error in established mode;*

*Used combined control, implemented on the principles of compensation under load of the unit and feedback with a loop for FADCH, increasing the speed of the respective frequency regulators in DEA.*

*The developed precise regulator of the angular frequency and phase for progress of SG within DEA, with reported specific for the respective fuel equipment, increased speed in the transient mode (regulation time up to 2 s) and zero error often and phase in the established mode of operation and gives possibility for parallel operation of several units;*

*Specialists in this area can use it not only in a specific development, but also in laboratory tests the obtained model of a fuel pump from a V-2 diesel engine, equipped with an all-mode centrifugal regulator, in the form of a nonlinear non-stationary second-order differential equation.*

*The developed current protection system ensures fast and reliable implementation when using a short circuit or after overloading the unit, as well as prevention of false positives when connected in parallel;*

*The developed specific solution for a system for reconstruction and modernization for the respective DEA implements sound management approaches and principles. The economic effect of the implementation of data in the network has been proven, which shows the expediency of use in the agricultural sector, where a large effect is expected. The system was implemented and created during the year and a half in real conditions in Perelik Hotel, Pamporovo resort.*

▪ **Book based on the PhD Thesis.**

**Г6.1. Румен Костадинов Попов.** Control systems for diesel electric stations. Марти-Дени Груп, 2019, 200 стр. ISBN - 978-619-7207-16-3; COBISS.BG-ID - 1289838820, <https://plus.bg.cobiss.net/opac7/bib/1289838820>.

*The book is intended for students of the educational qualification degree "Master" in the specialties "Electrical Engineering" and "Electrical Technology" in higher technical schools. It could also be useful for PhD students in Professional field 5.2. Electrical engineering,*

*electronics and automation. The published book is a book written on the basis of a defended dissertation for the award of educational and scientific degree "Doctor".*

*The author expresses gratitude and appreciation to Prof. Dr. Sc. Eng. Kondyu Yordanov Andonov, Assoc. Prof. Dr. Eng. Ivan Dragotinov Ivanov and Assoc. Prof. Dr. Eng. Emil Konstantinov Kuzmanov for their help, recommendations and suggestions in creating this book.*

*The contribution of the reviewers Prof. Dr. Eng. Ivan Yordanov Palov and Prof. Dr. Eng. Hristo Kanchev Stanchev, as well as the editor Assoc. Prof. Dr. Eng. Slavi Yassenov Lyubomirov should be emphasized. Their notes helped make the book better.*

## ▪ **Articles**

### ➤ **Articles that are referred and indexed in worldwide databases with scientific information**

Г7.1. A. G. Georgiev, R. K. Popov, E. T. Toshkov. (2016). In-situ measurements of ground thermal properties around borehole heat exchangers in Plovdiv, *J. Bulgarian Chemical Communications, Vol. 48, Special Issue E*, ISSN: 0324-1130, pp. 19 - 26. Impact Factor 0.229.

**(Web of Science, Scopus)**

*The knowledge of the geo-data (subsurface characteristics) is important for the design and construction of the Underground Thermal Energy Storage (UTES) and to design an installation using Borehole Thermal Energy Storage (BTES) - it is a big advantage during the project calculations and the construction of the geothermal systems. In situ determination of ground thermal conductivity, borehole thermal resistance and undisturbed soil temperature can be done by installing a vertical borehole heat exchanger (BHE) and performing the so-called Thermal Response Test (TRT). This paper describes the determination of ground thermal properties by a research group of the Technical University of Sofia, Plovdiv Branch. A mobile system for conducting Thermal Response Test has been created recently in Plovdiv, Bulgaria. The first Bulgarian TRT was carried out in January 2009 using a 41 m deep BHE, constructed in November 2008. Later tests are carried out on other two constructed BHEs in Plovdiv (single and double, 50 m depth and 32 mm diameters of the U-tubes). The tests were realized while the ambient temperature, the inlet and outlet fluid borehole temperatures and the temperatures of the BHEs at different depths were measured every minute. A large quantity of experimental data was gathered and analyzed by two parameters curve fitting based on the analytical formula of the Line Source Model for temperature distribution in the borehole (determining the ground thermal conductivity and the borehole thermal resistance). The detailed study of ground properties in different regions of Bulgaria is a good precondition for future application of the geothermal technology in the region.*

Г7.2. N. Vassileva, A. Georgiev, **R. Popov**. (2016). Simulation study of hybrid ground-source heat pump system with solar collectors *J. Bulgarian Chemical Communications, Vol. 48, Special Issue E*, ISSN: 0324-1130, pp. 71 - 76. Impact Factor 0.229.

**(Web of Science, Scopus)**

*A simulation model of a hybrid thermal heating and cooling system consisting of solar collectors, vertical borehole heat exchangers and heat pump is presented in this article. The system model is built in the "TRNSYS studio" simulation environment and allows to explore different modes of operation and to analyze an influence of system parameters on performance characteristics. The model describes the behavior of a real laboratory installation and will be used for the optimization of its operation and costs. TRNBuild application was used to design the building model and allowed sample way to change model properties. The developed model could be a useful tool in hybrid heating and cooling system design process. Simple procedure needed to adopt model to any different system size and components parameters.*

Г7.3. S. N. Lishev, **R. K. Popov**, A. G. Georgiev. (2016). Specialized measuring system for analysing thermal fields in hybrid systems. *J. Bulgarian Chemical Communications, Vol. 48, Special Issue E*, ISSN: 0324-1130, pp. 96 - 101. Impact Factor 0.229.

**(Web of Science, Scopus)**

*The analysis of thermal fields requires the collection and processing of information about the temperature in many points in the zone that is under investigation. A specialized autonomous measurement system, developed by Bulgarian scientific team from Plovdiv is presented in the article. It enables long-term recording of temperature data in more than 100 points. The system is designed for analyzing thermal fields in Phase change materials storages in hybrid systems. It is also suitable for related applications like chemical and biochemical reactors, and columns, if the temperature is in the range of -20 ° to +125 °C. Data is stored in SD-card and can be transferred via USB interface to the PC by specialized software, where the thermal fields could be visualized.*

Г7.4. Konstantinos Tsagarakis, Amaryllis Mavragani, **Rumen Popov**, Alexander Georgiev, Christina Kamenova. (2016). 'Clean' vs. 'Green': Redefining Renewable Energy Evidence from Bulgaria. *J. Bulgarian Chemical Communications, Vol. 48, Special Issue E*, ISSN: 0324-1130, pp. 254 - 259. Impact Factor 0.229.

**(Web of Science, Scopus)**

*Renewable Energy Sources. Are they 'Clean' or are they 'Green'? What do those with no previous or biased experience think? This study examines how the term "Renewable Energy" is viewed by primary school students in Bulgaria. For this purpose, a faceto-face survey was applied, aiming at the elicitation of the students' preferences for the naming and the colour that best represents Renewable Energy Sources. This was done with an in-class information project, followed by the completion of a questionnaire. Findings contradict what is, so far, established, i.e. that Renewable Energy Sources are 'Green' and that Renewable Energy is 'Green Energy'.*

Г7.5. Rumen **Popov**, Ivan Bozhikov, Slavi Lyubomirov, Krasimir Kehayov. (2020). Development of a cost-effective high accuracy multichannel RTD signal conditioner. *Proc. of SIELA 2020 Conference, 3 – 6 June 2020, Bourgas, Bulgaria*, pp. 375-378. ISBN 978-1-7281-4345-3 <https://tu-sofia.bg/conferences/208>.

**(Web of Science, Scopus)**

*The paper discusses the development and testing of a multi-channel RTD signal conditioner designed to study hybrid heating and cooling systems, which include two or more energy sources: solid fuel boiler; heat pump system and/or solar collectors. An "Expansion card" has been developed to increase the number of the analogue RTD channels provided by DAQboard LabJack UE9 and to ensure high accuracy of temperature measurements at the price about 0.5 Euro per channel.*

Г7.6. Lyubomirov, S., Shehova, D., **Popov, R.**, Ismail, S. (2020). Development of software modules for realization of APRS-based Tracker with application in engineering education, *Proc. of 14th ITED Conference, 2-4 March 2020, Valencia, Spain*, pp. 5244-5252, ISBN: 978-84-09-17939-8, ISSN: 2340-1079, doi: 10.21125/inted.2020.1420.

**(Web of Science, Scopus)**

**Разработване на софтуерни модули за реализация на APRS-базиран Tracker с приложение в инженерното образование**

*The conceptual idea of the authors of this article is to develop software for the implementation of an APRS-based tracker designed to train students studying Masters courses at higher technical schools in Computer and Communication Systems as well as Hardware and Software Systems.*

*The article presents software modules of the APRS™ (Automatic Packet Reporting System) based tracker, which is a type of digital radio amateur radio packets used to determine real-time location of a subject. It has been developed and approbated in the educational process at the Faculty of Physics of the University of Paisii Hilendarski.*

*APRS is an individual national channel that provides a mobile radio amateur link around the world, which can be used to track real-time events in the surrounding area from 10 to 30 minutes. The information that is transmitted on the network may include short messages, SOS alerts and meteorological conditions reports. The APRS network is well-developed in all countries around the world as the main carrier frequency in each continent varies from the country's standardization.*

*The APRS based tracker is an engineering solution that is a product of the successful operation of the APRS network with the reliability of the GPS system. Students acquire lasting knowledge and skills to work with APRS trackers linked between GPS and radio that modulate data on AX25 and APRS protocol and radios that transmit data to the global APRS network. The device with a host of up-to-date applications is available thanks to the combination of modern microcontrollers with appropriate software and APRS technology.*

*The engineering tasks undertaken by students in the implementation of the device are limited to: appropriate choice of microcontroller, development of I/O board, selection and development of suitable software for correct operation and testing the reliability of the device.*

*The article demonstrated the functional tests of the developed software modules and presents the results of the conducted outdoor test - the GPS module connects with satellites for 6 seconds; repeated indoor test - in order to get a more accurate result (for which the GPS (Global Positioning System) module connects from 14 to 90 seconds). Also, the article shows the results from a conducted test in a moving vehicle at an average speed of 50km / h. In this case the GPS module connects to satellites for about 2 to 5 minutes.*

*The choice of network communication focuses on the fact that the APRS network is developed globally and there are the so-called orbital APRS repeaters. It is flexible even in cases when one or more of its units fail and can produce real-time communication and collaboration with advanced technologies.*

*The developed APRS tracker can be applied to the following spheres: mountain tourism and mountaineering, expedition missions in hard-to-reach areas, forest fires, organizing and managing long-term rescue operations after a natural cataclysm, organizing and maintaining the operation of rescue posts, searching and transporting people in hard-to-reach mountainous terrain at the request of competent authorities.*

Г7.7. Bozhikov, I., **Popov, R.**, Lyubomirov, S., Shehova, D. (2020). Analysing the reasons for computer system failures through the focus of engineering training. *Proc. of 13th annual ICERI Conference, 9th-10th November, Spain*, pp: 8940-8945, ISSN: 2340-1095, ISBN: 978-84-09-24232-0, doi: 10.21125/iceri.2020.1976.

**(Web of Science, Scopus)**

*The main purpose of the article is to present the authors' research about the integration of a new approach in the educational process of students from computer specialities in higher education. The aim is to overcome the difficulties associated with the study of computer subjects and the development of competencies in students. Also, it is intended to support students' personal development and reduce the habits that obstruct their successful implementation of the approach. The document discusses the main reasons for computer system failures as well as hardware and software failures. The main points that the authors present in the research are temperatures of the components outside the allowable operating temperature range; abnormal parameters of the voltage, frequency and spectral composition of the supply line; incorrectly selected power supply; low-quality computer components; poor packaging of the computer equipment by the manufacturer; natural disasters and accidents. All these issues are important for a good understanding of the reasons for hardware failures by the trainees in order to be able*

to successfully participate in engineering teams that consider designing highly reliable energy control systems.

The continuous development of modern technologies, as well as the demand and supply of new computer systems, lead to the need for in-depth knowledge by students regarding the proper function of the systems. The article presents a tabular analysis of the results obtained regarding the main reasons for computer failures that cause data loss. The percentage of failures of the computer components in the hardware is specified. The results of the performed statistical researches, concerning the reasons for the failures of the hard disks after the processing and the analysis of 290 000 failures of the hardware in the data processing centres are graphically visualized.

Our experience in using these approaches shows that they can be successfully used to clarify the nature of these problems. They are useful for increasing students' motivation for self-studying and consolidating their knowledge. The data obtained from the conducted statistical analysis of the causes of computer failures is used not only for the theoretical training of students, but also serves as a link to their direct application in practical training courses. For example, the analysis of the reasons for failures related to the increase in the operating temperature of the computer components determines the conduct of practical classes related to the improvement of cooling. The educator provides a demonstration of the process of cleaning the heat-sinks, replacement of the thermal conductive paste of the processor, lubrication, replacement of the fans, etc. The students then perform the same procedures one by one and analyse the mistakes that were made. Similar practices are performed with hard drives, RAM, power supplies, network equipment and more.

Overcoming the difficulties associated with the study of computer systems will support the professional preparation of students and their successful implementation.

Г7.8. N. Paunkov, S. Lyubomirov, V. Rangelova, **R. Popov**. (2021). Virtual system for generating and measuring real time signals used in e-learning. *Proc. of INTED2021 Conference 8th-9th March, Spain*, pp. 10051-10058, ISBN: 978-84-09-27666-0.

[\(Web of Science, Scopus\)](#)

This article presents a development of a virtual system for generating and measuring real time signals. It has been used successfully in the distance learning of bachelor students from the Technical University of Sofia - Plovdiv branch in the discipline "Electronic Measuring Instruments and Primary Transducers". A virtual functional generator equipped with two real output signals has been developed using an DAC-module, which is built in the computer. For that purpose, a built-in soundcard of the personal computer is being used. By using the soundcard RealTek ALC269 real signals are produced in the form of AC voltages, through the audio jack of the soundcard. The generator is fully functional and it can form three different type of the output signals – sine, triangular and rectangular.

Virtual measurement tool has also been developed in order to measure the parameters of the produced by the virtual functional generator real time signals. It could be also used for other real time signals parameter measurement. This tool contains an oscilloscope and a spectrum analyser. In that way students can solve various tasks related to the study of the signals' shape, measuring frequency, amplitude and observing the waveforms. Additionally, a noise can be added to the signal and some other tasks can be done too.

The accuracy of the measurement with the observation tool is checked with an additional oscilloscope model Siglent SDS1052DL 50MHz. The relative errors of the frequency and amplitude measurement produced by the developed tool are similar to these done with Siglent.

The spectrum analyzer implemented in the measuring tool gives the opportunity to make a spectral analysis of the generated signals and allows the students to become familiar with that kind of the measurements.

The workability of the virtual functional generator and the virtual measurement tool has been proven by a lot of experiments. According to the results, we can conclude that both based on virtual instrument technology can meet the requirements of high-precision and stable low and

medium frequency in many fields. Different types of frequencies, amplitudes and output waveforms produced by the developed virtual functional generator can be set through PC control panel and the parameters of the signals generated through the DAC-modules output could be measured using developed Measurement Tool.

Oscilloscopes are an integral tool for those designing, testing, or repairing electronic equipment. Their applicability is very wide in different industries, this means that the students from technical specialties should have a lot of knowledge about this tool. The same goes for the generator and the spectrum analyzer. They are used in the fields of electronics, measurement systems and automotive electronics, also each school or university in these fields, can take the advantage and teach their students with it, with a progressive method, that doesn't require separate equipment or laboratories, but everything can be thought and done from one room and one device. Therefore, this generating and measuring becomes very appropriate for distant learning purposes.

From an economical point of view, we have developed a tool that is functional, user friendly and relatively cheap compared to the overall market. It can be used easily in the real work place or classroom without any additional components, directly with the most common device, computer or in distance education.

Г7.9. N. Paunkov, S. Lyubomirov, **R. Popov**, D. Shehova. (2021). Implementation of virtual statistical measuring instruments in engineering education during covid-19. *Proc. of INTED2021 Conference 8th-9th March, Spain*, pp. 9801-9809, ISBN: 978-84-09-27666-0.  
[\(Web of Science, Scopus\)](#)

*The COVID-19 pandemic and the measures taken to combat the spread of the virus could cause unwanted problems in providing educational and mobility opportunities for students and teachers in the European Union (EU). The education sector responds to quarantine by moving to online learning.*

*Online teaching requires specifying how learners and teachers are prepared to respond to change and refine the effectiveness of teaching methods and tools. Digital learning management systems, communication tools and e-learning platforms play an important role throughout this pandemic. Software and applications can help learners manage, plan, deliver, and track the learning process.*

*The authors in this article identify new directions in the development of information management technologies and measurement, control and regulation systems. The use of computer-based measurement and control systems, known as PC-based Data Acquisition (DAQ) systems and control, based on specialized PC boards, modules and components, is required.*

*A virtual statistical data processing tool has been developed and tested. It is used for training bachelor and master students in the discipline of electrical measurements. The data is taken from a real working installation. The virtual tool is integrated into a real-time online software system.*

*A statistical virtual tool has also been developed to check the distribution of data obtained from multiple measurements. The tool is implemented in the LabVIEW programming environment and this allows it to be embedded as a module in more complex data processing programs. The statistical virtual tool is based on the LabVIEW software platform developed by NI - Instrument. It consists of a LabJack UE9 data acquisition module (DAQ) and an expansion card that increases the number of measurement channels through virtualization. The measured values can be temperature, voltage and current through the respective sensors. The information from the sensors converted into an electrical signal falls on the input of differential amplifiers of the respective channels of the expansion card.*

*The created virtual tool has the following functions: Construction of Errorbar of the studied quantity with or without adding to it the information about the total uncertainty; function for constructing a distribution histogram, quantile by quantile, manually or automatically; a function for calculating the Chi-Square estimate that is based on Pearson's algorithm.*

*The results are processed in the following sequence: exclusion of gross and systematic errors; determining the type of distribution of the results of repeated observations; elimination of uncertainty in the final result due to random errors.*

*Students conduct statistical tests based on a sample taken from a real working measuring system of an installation for measuring the parameters of photovoltaic PV and PVT panels. The setup and verification of the developed tool are performed based on the performed experiments on SPSS and Excel. A reference generator simulating a normal distribution is added to the created Chi-Square test.*

*The file generated by the measuring system contains information about 599 attempts. When set with the N-Opity potentiometer and Multiplayer 599, all experiments and their uncertainty as a result of the measurements are visible.*

Г7.10. **R. K. Попов**, A. G. Georgiev, D. B. Dzhonova-Atanasova. (2016). Parameter estimation of borehole thermal properties using artificial intelligence methods. *J. Bulgarian Chemical Communications, Vol. 48, Special Issue E, ISSN: 0324-1130, pp. 88 - 95. Impact Factor 0.229.*

**(Web of Science, Scopus)**

*There are many estimation techniques, which are used in Thermal Response Test (TRT) data analysis. The commonly used models, Line Source Model, Cylindrical Source Model, numerical models do not take into account the nonlinear system effects like for example the phase change. The present work suggests the use of the input/output black box identification technique for TRT data analysis. A nonlinear autoregressive exogenous (ARX) model structure and stochastic search algorithms are used to estimate model parameters. Artificial intelligence techniques, Genetic Algorithm and Particle Swarm Optimization Algorithm are employed to avoid local maxima problems. The study is based on data sets obtained during real TRT tests without phase change effects. All analyses are performed in MATLAB environment. The purpose of this paper is to verify that the proposed algorithms are suitable for processing of TRT data with the aim of future identification of thermal parameters of boreholes with phase change effects. The given solution is also useful when common techniques fail in search for the global optimum if the search space is not differentiable or linear in the parameters.*

#### ➤ **Научни публикации в неререферирани списания с научно рецензиране**

Г8.1. М. Калбанов, **Р. Попов**. (2013). Проектиране на фотоволтаична централа. *Journal of the Technical University Sofia, branch Plovdiv "Fundamental Sciences and Applications", Vol. 19, Book 1, pp. 167-172. ISSN 1310-8271.*

#### **Photovoltaic generation plant design.**

*Conceptual project for grid connected 1 MW photovoltaic generation plant, located near village Resen, Veliko Tarnovo region, was developed. The project stages, methods, instruments and results are described. The solar radiation resources and the main technical properties of the plant were determined. The complete equipment set variant was chosen. Financial analyses were accomplished and the photovoltaic generation plant technical requirements were defined. The plant ecological impact was analyzed and estimated.*

Г8.2. A. Stoyanov, A. Georgiev, **R. Попов**. (2013). Experimental installation for investigation of latent heat accumulator as a part of hybrid system for air-conditioning. *Издателство на ТУ Варна, Топлотехника, год. 4, книга 2, стр. 28-31. ISSN 1314-2550.*

*An experimental installation consisting of latent thermal storage charged by solar energy was constructed and implemented. It is used to explore its applicability as an element of a hybrid air conditioning system. The system is built in the Laboratory of "Renewable Energy Sources" at the Technical University of Sofia, branch Plovdiv. The system consists of latent thermal storage, solar collectors, solar water heater and circulating pumps.*

- Г8.3. E. Toshkov, A. Georgiev, **R. Popov**. (2014). Measuring System of a Hybrid Installation with Ground Source Heat Pump and Solar Collectors. *Journal of the Technical University Sofia, branch Plovdiv "Fundamental Sciences and Applications"*, Vol. 20, pp. 33-38. ISSN 1310-8271.

*The measuring system of an installation with ground source heat pump and solar collectors for air conditioning of residential buildings is presented in this article. The sensors for parameter measuring of the system and the devices for data collecting and treatment are described. An analysis is performed which parameters are to be measured at different installation working modes - heating, cooling and changing of the ground by means of various sources of energy.*

- Г8.4. **Р. Попов**, Р. Казакова. (2014). Изследване на стохастични алгоритми за оценяване на параметрите на хаотични системи. *Journal of the Technical University Sofia, branch Plovdiv "Fundamental Sciences and Applications"*, Vol. 20, pp. 95-102. ISSN 1310-8271.

#### **Research on statistical algorithms for parameter estimation of the chaotic systems.**

*The possibility to apply statistical algorithms for parameter estimation of the chaotic systems is investigated. The Genetic Algorithm (GA) and Particle Swarm Optimization – (PSO) are approved in Lorenz chaotic systems' parameter estimation task. The Monte Carlo simulations and uncertainly analysis of the factors (F-tests) are performed. The results are compared and analyzed.*

- Г8.5. Р. Казакова, **Р. Попов**. (2014). Структурна идентификация на системи с използване на алгоритми на изкуствения интелект. *Journal of the Technical University Sofia, branch Plovdiv "Fundamental Sciences and Applications"*, Vol. 20, стр. 103-108. ISSN 1310-8271.

#### **Structural system identification using artificial intelligence algorithms.**

*The possibility to apply stochastic algorithms for structure estimation of the linear systems is investigated. The Genetic Algorithm (GA) and Particle Swarm Optimization – (PSO) are approved to estimate order of the Autoregressive exogenous (ARX) model. The Monte Carlo simulations are performed and the results are analysed.*

- Г8.6. S. Lishev, **R. Popov**, A. Georgiev. (2015). Laboratory SCADA Systems – the State of Art and the Challenges. *Balkan journal of electrical & computer engineering*, Vol.3, N° 3, pp. 164-170. ISSN: 2147-284X.

*The present review considers the hardware and control system structure of the modern SCADA systems. The commonly used communication infrastructure and data transmission protocols are described. Especially the trends in using wireless communication technology applications are analyzed. A number of different SCADA system applications are represented and its advantages and disadvantages are also discussed.*

- Г8.7. Aleksandar Georgiev, Mehmet Shahin, **Rumen Popov**, Kurtulush Deger, Nadezhda Vassilieva, Emil Toshkov. (2015). Simulation of Hybrid Thermal Installations. *Proc. of the 17-th. International Conference on Emerging Nuclear Energy Sciences, İstanbul, Turkey, 04-08 October*. [http://e-university.tu-sofia.bg/e-publ/files/2457\\_Paper1039.pdf](http://e-university.tu-sofia.bg/e-publ/files/2457_Paper1039.pdf).

*Increased scientific and technological efforts have been made recently to reduce the carbon dioxide emissions in the environment as a main cause of the global warming. The general trend is using Renewable Energy Sources. The aim of the present work is a brief review of the advantages of the hybrid thermal systems (HTS) using Renewable Energy Sources. The article presents methods and instruments for mathematical modeling and simulations of the main components of the HTS and its operation as a whole.*



- Г8.8. **R. Popov**, A. Georgiev, N. Vasileva S. Lishev. (2015). Optimal Position Sensor for Orientation of Photovoltaic Plants. *Journal of the Technical University Sofia, branch Plovdiv "Fundamental Sciences and Applications"*, Vol. 21, pp. 169–174. ISSN 1311-9974.

*The produced volume of an electrical energy in non-concentrated, photovoltaic plants may significantly increase if the panel orientation is changing, to follow the optimal position. There are a number of methods and sensors, used to find the PV panel optimal orientation, which depend not only on sun position, but on sky (sun) insulation factors, too. In some cases the diffuse component of the solar radiation produces much more electricity, then direct one. In this article sensor for direct, real time measurement of an optimal PV plant orientation position is proposed. It uses a rotating sensor array, oriented at different tilt angles and scanning the sky. The microcontroller unit performs measurement and control algorithm and allows calculated data through RS485 interface connection.*

- Г8.9. Manatbayev R. K., Georgiev A., **Popov R.**, Dzhonova-Atanasova D., Kuikabayeva A. A., Zулbukharova E. M. (2016). The effect of design parameters on energy characteristics of Darrieus rotor. *Int. J. of Mathematics and Physics* 7, №1, 94, pp. 94-98.

*In the last 10-15 years the use of wind energy is growing. There are more than 20,000 wind power turbines with a total capacity of more than a few megawatts in the world. Kazakhstan has significant wind power resources. Resources of the Jungar gate and Shelek complex in Almaty region are the best known in this respect. Their capabilities for use in electricity generation of air flow are unique. This article describes the main types of wind turbines and the benefits of Darrieus rotor over other wind turbines. The article provides the basic calculations to determine the effect of the wind turbine Darrieus design characteristics on its energy efficiency. This article shows the dependence of the maximum utilization coefficient of wind energy vertical axis windwheels from the number of blades with constant filling factor  $a$ , from the number of blades with their constant width, from blades elongation  $A$ . Design characteristics for 1 kW rotor were identified based on these results. Also, wind turbine scheme, that can provide thermal protection by warm air natural ventilation in the rotating elements of wind turbine which arises due to centrifugal forces, is shown.*

- Г8.10. Tannur Amanzholov, Bakytzhan Akhmetov, Aleksandar Georgiev, Aidarkhan Kaltayev, **Rumen Popov**, Daniela Dzhonova-Atanasova, Rustem Manatbayev, Madina Tungatarova. (2016). Installation for thermal response test implementation. *Proc. of the 15th Int. Scientific Conf. "Renewable energy & Innovative technologies"*, 10 - 11 June, Smolyan, Bulgaria, Vol. 1, pp. 164-168. ISBN: 978-619-7180-78-7.

*Nowadays, development of efficient thermal energy storage systems is becoming very important since they assist in storing gained energy from renewable energy sources at medium or large scales in an effective way with the purpose of balancing the energy demand and supply. One of the technologies, which allows storing thermal energy in a large-scale, is Borehole Thermal Energy Storage (BTES). Such technology gives opportunity to store heat into the ground and/or groundwater in summer, and extract it in winter. To evaluate the BTES performance, the ground thermal properties must be known. One of the in situ methods for this purpose is the Thermal Response Test (TRT). In order to carry out the TRT, a special installation must be developed. The current paper presents a TRT installation and its constituent parts developed by the authors. A special attention is paid to the compact size, performance, and appropriate order of the sequentially connected parts of the installation, since the carefully built system ensures precise measurements of the borehole thermal resistance and the effective thermal conductivity of the ground around the borehole.*

- Г8.11. Akhmetov B., Seitov A., **Popov, R.**, Georgiev A., Kaltayev A. (2017). Experimental and numerical studies of PCM-based storage for solar thermal energy storage applications.

*In the world, buildings are responsible for 40% of the world's total annual energy consumption, which is responsible for one-third of greenhouse gas emissions worldwide. The significance of this energy is used for lighting, heating, cooling and air-conditioning purposes. Raising concern about the environmental impact of greenhouse produced by conventional power plants caused renewed interest in environmentally friendly technologies, including heating and cooling systems for buildings. This work was conducted to investigate and explore the possibilities of solar energy storage using phase change materials (PCM) and using that energy to heat water for daily applications. By carrying out charging of the latent heat storage (LHS) based on PCM which is paraffin wax in the current study, its energy storage capacity was calculated and compared with the storage tank without PCM but filled with water only - sensible heat storage (SHS). As a result, LHS was able store 40% more thermal energy compared to SHS. Moreover, charging process of the LHS was numerically investigated to visualize the thermal field in the PCM based storage. The results show that the numerical results agree with the experimental results which indicated the correctness of the mathematical model and simulation results.*

Г8.12. Paunkov, N., **Popov, R.**, Manatbayev, R., Kalasov, N., Zulbuharova, E., Tulepbergenov, A., Nedelcheva, S., & Georgiev, A. (2017). Efficiency comparison of photovoltaic and photovoltaic-thermal solar panels. *International Journal Of Mathematics And Physics*, 8 (1), 28-33. doi:10.26577/ijmph.2017.v8.i1.05. ISSN: 2218-7987 (Print); ISSN: 2409-5508 (Online).

*The photovoltaic (PV) solar panels are getting bigger applications in the practice. Their efficiency is better at lower temperatures. Normally the panels are cooled with the ambient air (in this case the gained heat is dissipated to the surrounding without any application). A successful combination of photovoltaic solar panel and solar collector is the so called photovoltaic-thermal (PV/T) solar panel. There are some significant advantages of the PV/T panels - aesthetic advantage over the PV panels, usage in places where the area is limited, reduction of the installation costs and architectural unity between roof and PV/T panels. The article analyses two solar panels - the PV solar panel of the type polycrystalline silicon (pc-Si) and the PV/T Solar Module CPVT60P250 (both solar panels are produced by the Crane Company using silicone cells from EKS - Solaris GmbH). Some tests are implemented and a comparison between the efficiencies of both panels is done.*

Г8.13. D. Dzhonova-Atanasova, **R. Popov**, A. Georgiev. Challenges of Marine Power in the Balkan Region. *Balkan journal of electrical & computer engineering*, ISSN: 2147-284X, 2013, Vol.1, N° 2, pp. 85-92.

*The world power generation is in a process of transition from fossil fuels to renewable and sustainable power sources. The part of the electricity from alternative energy technologies is growing rapidly. New engineering approaches and devices are continuously created by the researchers in the field of power engineering, aimed at obtaining energy with less harm for the environment and the life on the planet. The present work is an initial evaluation of the possibilities for marine energy conversion in the Balkan region. The focus is on energy from the sea including energy from waves, currents, salinity, temperature difference etc. The main purpose of the work is on the basis of assessment of the power potential determined by the geographical characteristics of the seas in the region and the scientific, technological and economical level to make some conclusions about the prospects in this area.*

Г8.14. E. Toshkov, A. Georgiev, **R. Popov**, N. Vassileva. (2015). Investigation methods of hybrid Ground Source Heat Pump system with solar collectors. *Proc. of the Union of scientists, Ruse. 6-th Int. Conference "Energy Efficiency and Agricultural Engineering"*, Ruse, Bulgaria, November 11-12, pp. 55 – 62. ISSN 1311-9974.

*Methods to investigate a hybrid Ground Source Heat Pump (GSHP) system with solar collectors were devised. The aim of the methods is to determine the thermal characteristics of the system at different operation regimes depending on the season and the heating loads. The investigation procedure is mentioned in the article. The determination of the solar collector efficiency, the coefficient of performance (COP) of the heat pump, the efficiency of the borehole heat exchangers (BHE) and the efficiencies of the hybrid system at different operation regimes is presented. The investigation conditions, the processing of the test data and the accuracy of the measured parameters are discussed.*

#### ▪ **Textbook**

1. **Румен Костадинов Попов.** Програмируеми логически контролери - Ръководство за програмиране на контролери Zelio Logic. *Академично издателство на ИИИТ- Пловдив, 2021 г. стр. 128, ISBN 978-619-91382-6-7. (Учебник по дисциплината „Програмируеми логически контролери“)*

#### **Popov, R.K. Programmable Logic Controllers - Zelio Logic Controller Programming Guide.**

*This textbook is a detailed tutorial for programming Zelio Logic controllers. It is divided into topics, and in each topic the necessary theoretical material is given first in order to perform specific practical tasks, and then the tasks aimed at the practical mastering of the material are given.*

*The textbook is designed for students majoring in "Telecommunications and Information Systems" and "Information and Computer Engineering", as a base for the discipline "Programmable Logic Controllers". It can also be used by students from other specialties, as well as by engineers who want to improve their skills in the field of programmable logic controllers. It is written as a basic level and allows effective mastering of the material in self-preparation mode, as the ZelioSoft software of the company Schneider Electric is free and has a full-function simulator.*

#### ▪ **Ръководства**

1. **Румен Попов.** Solar Radiation Measurement - Guide on Solar Radiation Energy and Lighting Calculations. *Академично издателство на ИИИТ- Пловдив, 2021 г. стр. 80, ISBN 978-619-91382-3-6. (Ръководство за семинарни упражнения по дисциплината „Solar Radiation Measurement“)*

*This book is intended for students of the educational-qualification degree "Bachelor" and "Master" in the specialty "Technologies in Eco-Energy" as a laboratory guide for the course of "Solar Radiation Measurement". It may be also used by students teaching in "Electrical Engineering" and "Electric Power Technologies" in higher technical schools.*

*The author expresses gratitude and appreciation to Prof. Ivan Milenov, Assoc. Prof. Dragomir Gospodinov and Assoc. Prof. Vanya Rangelova for their help, recommendations and suggestions in creating this book. Their notes helped make the guide better.*

2. **Румен Костадинов Попов.** Сигнали и системи. *Академично издателство на ИИИТ- Пловдив, 2021 г. стр. 128, ISBN 978-619-91382-5-0. (Ръководство с комплект индивидуални задания за семинарни упражнения по дисциплината “Сигнали и системи”)*

#### **Popov, R.K. Signals and Systems.**

*This guide is a set of seven assignments for individual tasks by students in the disciplines "Signals and Systems" and "Fundamentals of Communications". The assignments are performed in a computer class, in the middle of Matlab, and for this purpose they need to have prior preparation for programming with Matlab. The seminar course is designed for ten 3-hour*

classes. The first 3 classes are for basic training in Matlab, and the next 7 - for individual assignments.

The manual is intended for students in the bachelor's specialties "Telecommunication and Information Systems" and "Information and Computer Engineering" and "Telecommunications with Management". It can also be used by students from other specialties, as well as by engineers who want to improve their skills in the field of signal processing. It is written as a basic level and allows effective mastering of the material in self-preparation mode, as the MATLAB software of the company MathWorks has a one-month free student version.

3. **Румен Попов.** Сензори и изпълнителни механизми. Академично издателство на ИИИТ- Пловдив, 2021 г. ISBN 978-619-91382-7-4 (електронно издание: видео-упражнения по дисциплината „Сензори и изпълнителни механизми“)

**Popov, R. Sensors and actuators.**

*This edition is a set of seven video exercises in the discipline "Sensors and actuators". A text file with detailed instructions has been added for the correct performance of each exercise. Where necessary, a link to additional explanatory materials and / or reference tables is provided. After watching the video exercises, students make individual reports (protocols of measurements and data processing), for which purpose each student uses an individual data set. The exercises are started from the main menu, designed as an html-page.*

*The manual is intended for students majoring in "Information and Computer Engineering", "Hardware and Software Systems" and "Electrical Engineering" of the Faculty of Physics and Technology of PU "Paisii Hilendarski".*

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