HEIn4.0

Boosting the role of HEIs in the industrial transformation towards the Industry 4.0 paradigm in Georgia and Ukraine / HEIn4

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HEI: ***Akaki Tsereteli State University***

SYLLABUS

"Integration of Industry 4.0 in a Renewable Energy"

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Educational course/module name	Integration of Industry 4.0 in a Renewable Energy
Course Code	
Author/authors (Lecturer, lecturers, course executors)	Associate Professor, Ph.D. Zaza Papidze
Faculty, department	Faculty of Technical Engineering, Department of Energy and Telecommunications
Education program	Power Industry Technology
Higher education level	Second (master's)
Semester	II
Course status	Elective
Language of tuition	Georgian
ECTS Credits: *Hours according to student's classes*	**5 Credits** 125 hours in total, including: **Contact - 48 hr.** Class hours – 45 hr, including: • Lecture - 15hr, • Practice training - 15hr, • Laboratory work – 15hr, Mid-term and final exams – 3hr; **Individual work – 77 hr.**
Course aim	The aim of the course is to equip students with the relevant basic knowledge about the advanced and rapidly developing technology of electrical engineering - Alternative Energy.
Prerequisites	Energy efficiency and energy-saving technologies
Course format	Lecture, practical training, laboratory work
Learning outcomes, the list of competences (general and field)	**Knowledge and understanding** - Basic knows about industry 4.0; - Names renewable energy resources, knows the basics of their formation and evaluation, technological schemes; - Knows equipment used for solar and wind energy; - Describes the methods of solar and wind energy development; - Has in-depth and systematic knowledge based on research findings;

	Skill analytical thinking - innovative solutions of engineering problems in Energy sector; -computer simulation of renewable energy systems, -is able to identify and define in detail opportunities and areas for the use of solar and wind energy resources. - defines the characteristics of renewable energy, can compile the necessary schemes for design, formulate and solve enterprise and design tasks. -is aware of the specific problems of the field and the ways to address them. - assesses the impact on the environment. . - **Responsibility and self-sustainment** Performs development-oriented activities in the work environment taking responsibility for it, implementing the principles of ethics of his/her own activities.

Competences		
Knowledge and understanding	**Skill**	**Responsibility and self-sustainment**
X	**X**	**X**

Teaching/learning methods	Verbal method; practical training; demonstration; brainstorming; discussion/debates; group work; presentation; research-based learning (performing presentation and thesis).
Student assessment system and criteria	**Student assessment system existing at Akaki Tsereteli State University is divided into the following components:** The share of mid-term assessment in maximum evaluation score (100 points), which in turn involves the following assessment forms: **Student's activity during the semester (includes different assessment components) – no more than 30 points;** **Mid-term exam - no less than 30 points;** **Final exam – 40 points.** Student has the right to take the final exam, if his/her minimum assessment score at mid-term exam is **at least 18 points**.

The assessment system envisages:
a) **five types of positive assessment**:
a.a) **(A) Excellent** – 91-100 points.
a.b) **(B) Very good** – 81-90 points.
a.c) **(C) Good** – 71-80 points.
a.d) **(D) Satisfactory** – 61-70 points.
a.e) (**E) Acceptable** – 51-60 points.
b) two types of negative assessment

b.a) (FX) Student could not pass exam – 41-50 points that means that Doctoral student is required to work more for passing this exam, and that she/he is given the right to retake exam only once after individual work;
b.b) (F) failed to pass –40 points and lower that means that the work done by Doctoral student is not sufficient and she/he has to redo the course.
Within the course component of the educational program, in case of FX assessment, a makeup exam is appointed no later than 5 days since the announcement of the final exam results**.**

The minimum assessment score on the final exam is **at least 15 points**

The number of points received by student on the final exam is not added to the make-up exam assessment score.

The number of points received on a make up exam is a final assessment score and is reflected in final assessment of the course component of educational program.

With account for the assessment received in the course component, in case of final assessment score 0-50 points, student is assessed at F-0 points.

Student's knowledge assessment criteria
The maximum assessment score (100 points) is distributed as follows:

Assessment components	Share of components (%)
Mid-term exam	30
Activity	30
Final exam	40
Total	100

<u>Assessment rubrics</u>
<u>Activity (discussion/debates, presentation) - 30 points</u>

Discussion/debates – 15 points
The students will be assessed three times (maximum, assessment score – 5 points)

	The midterm exam is held in written or oral form, The exam paper consists of six questions, and maximum score for each question is five points. **5 points**: student formulates his/her thought clearly and precisely, makes good judgments, draws conclusions, the opinion is original and is based on facts and concepts, has a logical connection with the issue, speaks fluently, has a rich vocabulary, uses creatively linguistic expression means and the forms of non-verbal communication (visual, gestures, voice), listens and responds to different opinions in a constructive manner, is correct towards the opponent, allows others to offer their opinions, follows the rules of discussion and time limits. **4 points**: student formulates his/her thought clearly, makes good judgments, draws conclusions, speaks fluently, uses correct syntactic and grammatical constructions, often is able to establish non-verbal communication, listens other's opinions and sometimes engages in discussions, is correct and demonstrates respect for other's opinions, mostly follows the rules of discussion and time limits. **3 points**: student, to some extent, is able to justify his/her opinion without facts and logical reasoning, follows the elementary rules of correct educated speech, speaks more or less fluently, rarely uses the forms of non-verbal communication, rarely listens to others and often engages in other people's conversation, does not always follow the rules of discussion and time limits. **2 points**: Student is not able to justify his/her own opinion, does not follow the elementary rules of correct educated speech, does not use the forms of non-verbal communication, does not listen to others and does not allow them to speak. **1 point**: Student is not able to speak clearly; **0 points**: Student does not participate in the discussion at all. **Presentation – 15 points** **The students will be assessed three times (maximum, assessment score – 5 points)** **5 points**: The beginning of the presentation is interesting and draws attention of the audience, the presentation material is accurately and comprehensively presented and contains original observations and evaluations; the terminology is correct; the presenter manages to keep the audience's attention throughout the presentation and responds adequately to the audience's questions and comments, effectively uses a wide range of visualization techniques (slideshow, handouts, posters, blackboard, etc.), observes the time limit. **4 points**: The beginning of the presentation is interesting and mostly draws attention of the audience, the presentation material is comprehensively presented; the used scientific terminology is appropriate; the presenter manages to establish contact with the audience and responds adequately to the audience's questions, the presentation is provided with effective visualization techniques, observes the time limit; **3 points**:The beginning of the presentation is interesting to some extent, the presentation material is incompletely presented; student rarely uses the appropriate terminology; student tries to draw the attention of the audience and more or less manages to answer questions; ineffectively uses visualization techniques, violates time limit.

2 points: The beginning of the presentation is not interesting. The presentation material is presented partially; the terminology is incorrect; student periodically tries in vain to draw attention of the audience and is unable to adequately answer questions, very rarely uses visualization techniques, cannot observe the time limit.
1 point: The presentation is not relevant to the subject, the presenter is not able to establish contact with the audience and does not use visualization techniques**.**
0 points: Student didn't do the task of presentation.

Mid-term exam - 30 points (theoretical issues).
The midterm exam is held in oral form, The student will be assessed on a scale from 1 to 10. The students will be given at least 15 questions in advance. The exam paper consists of three questions. To get the final grade in the midterm exam, the scores obtained in all three questions will be summarized.

Final exam - 40 points (theoretical issues)
The initial evaluation of student will be done **on a scale from 1 to 10**. S**tudents will be given at least 15 questions in advance. The exam paper consists of four questions. To get the final grade in the final exam, the scores obtained in all four questions will be summarized.**

The test question assessment criteria are as follows:

10 points - Student demonstrates systemic and in-depth knowledge of the subject, is thoroughly erudite in both compulsory and elective literature, uses precisely scientific terminology, sees linkages between events, distinguishes the essential characteristic from the secondary one; can critically and logically analyze facts, as well as formulate well-founded new conclusions.

9 points - Student is aware of only demonstrates in-depth knowledge of the subject, uses precisely scientific terminology, sees the connection between events, is able to critically analyze the facts, provide logical and well-reasoned judgments, as well as to draw conclusions with insignificant inaccuracies. Student demonstrates systemic knowledge of the subject, is thoroughly erudite in compulsory and partially in elective literature, uses precisely scientific terminology, can see linkages between events and think logically, formulates conclusions with minor inaccuracies.

8 points - Student studied only the basic compulsory literature, uses precisely scientific terminology, can logically analyze linkages between facts and events, can barely formulate some conclusions.

7 points - Student demonstrates knowledge of the subject not perfectly, but does not make significant and substantive errors, possesses a categorical concept tool

	typical of the subject, has a solid knowledge of terminology, can barely see and logically analyze linkages between events. 6 points – Student has insufficient knowledge of terminology, demonstrates knowledge of the subject that is sufficient for further studies and future professional careers. 5 points – Student completed at least half of the given assignment. 4 points - Relevant material on the subject is presented only partially, with essential errors. 3 points - Student has a general idea of the subject, but cannot link the fragments to each other. 2 points - Answer is substantially wrong and terminology is not used. 1 point - Answer is not appropriate for the subject. 0 points – No answer.
Compulsory literature sources	1. M. Keburia. Renewable, non-traditional energy resources. Akaki Tsereteli State University publishing house. Kutaisi, 2009, 441 p. (Georgian); 2. M. Keburia. Laboratory works in renewable energy sources. Akaki Tsereteli State University publishing house. Kutaisi, 2009, 54 p. (Georgian); 3. M. Keburia. Renewable energy sources – practical exercises. M. Keburia. Laboratory works in renewable energy sources. Akaki Tsereteli State University publishing house. Kutaisi, 2007, 48 p. (Georgian).
Free elective literature sources	1. D. Galar, P. Daponte, U.Kumar, Handbook of Industry 4.0 and SMART Systems, CRC Press, 2019, 386 p. 2. Mukund R. Patel. Wind and Solar Power Systems. Design, analysis and Operation. Taylor&Francis Group. 2006 3. Gary L. Johnson. Wind Energy Systems. Electronic Edition. 2006 4. Klaus Jager. Arno H. M. Smets. Solar Energy. Fundamentals, Technology and Sistems. Delft University of Technology. 2014 5. Theofilos D. Mastos et al. Industry 4.0 sustainable supply chains: An Application of an IoT enabled scrap metal management solution. 2020 https://www.sciencedirect.com/science/article/pii/S0959652620324240 6. Gunjan Yadav et al. A framework to overcome sustainable supply chain challenges through solution measures of industry 4.0 and circular economy: An automotive case. 2020 https://www.sciencedirect.com/science/article/pii/S0959652620301591

Content of the Course

No	Form of teaching	Name of topic	Number of hours
1	Lecture	Goals of INDUSTRY 4.0. Digitalization of information. The connection of the digital world with physical systems.	1
	Practical	Renewable energies. Energy resources. The importance of environmentally friendly energy sources.	1
	Laboratory	Familiarizing with photovoltaic training-laboratory equipment.	1
2	Lecture	The dominant technologies for INDUSTRY 4.0. SMART technologies	1
	Practical	Solar energy. Solar energy resources. The potential to use solar energy. Problem solving.	1
	Laboratory	**Heliostation with effective mountainous landscape**	1
3	Lecture	Efficiency of the digital industry for small and medium-sized enterprises (SME). Maturity index for SMEs	1
	Practical	Physical foundations of solar energy conversion processes Solar energy. Problem solving.	1
	Laboratory	**The landscape efficiency criteria. Statistics and estimated data**	1
4	Lecture	Photoelectric cells. Solar modules. Modern technologies of their production	1
	Practical	Problems related to the volt-ampere characteristic of a photovoltaic module	1
	Laboratory	Studying the direct solar radiation on a vertical surface	1
5	Lecture	Solar power installation. Schematic diagram of the machine. Design of heliosystems	1
	Practical	Practical work on the electrical characteristics of a photovoltaic module	1
	Laboratory	**Solar panel arrays. Nodes and components**	1
6	Lecture	Solar-based micro-energy system. Direct production of electricity from solar energy. Photoelectric converter circuit.	1
	Practical	Work on the abstract. (research)	1

	Laboratory	**Solar plant with two-axis tracker**	1
7	Lecture	Solar power plants. Operation of solar power plants in parallel with autonomous and common electrical system.	1
	Practical	Solar autonomous photovoltaic power plant operation Mode simulation	1
	Laboratory	Exposure of the dependence characteristic of the the short-circuit current light ray tilt angle in a photovoltaic module Iκ=f(φ).	1
8	Lecture	Brief information on aerodynamics. Air and its properties.	1
	Practical	Problems on aerodynamics	1
	Laboratory	Introduction to the natural model of the wind power installation	1
9	Lecture	Wing inductive resistance. Wing lifting force. Shift from one wing spinup to another	1
	Practical	Wing inductive resistance. Shift from one wing spinup to another	1
	Laboratory	Simulation of operating modes in an autonomous power plant	1
10	Lecture	Pros and cons of different system wind turbines. Theory of ideal and real wind turbines.	1
	Practical	Case study. Losses in wind turbines.	1
	Laboratory	Checking the working capacity of wind generator	1
11	Lecture	Method of obtaining experimental characteristics of wind turbines, aerodynamic tube, types of wind turbines. Determination of wind turbine power and number of revolutions	1
	Practical	**Evaluation of abstract work (analysis of retrieved information)**	1
	Laboratory	Investigation of the relationship between voltage, current, power and rotational frequency and the wind speed in wind generator	1
12	Lecture	Wind turbine. Accumulation of wind energy.	1
	Practical	Accumulation of wind energy.	1
	Laboratory	Determination of the amount of electricity generated during an experiment in a wind power equipment at an average wind speed	1
13	Lecture	Wind power plants	1
	Practical	Dependence of voltage, current and power on the wind speed in wind power plants	1
	Laboratory	Exposure of the mode characteristics of battery charging-discharging controller characteristics shooting	1

14	Lecture	Types of generators used in wind power plants. Voltage regulators.	1
	Practical	**Evaluation of abstract work (conclusions and recommendations)**	1
	Laboratory	Investigation of synchronous generators used in the wind power systems	1
15	Lecture	INDUSTRY 4.0 and society	1
	Practical	**Evaluation of abstract work (presentation and answers to audience questions)**	1
	Laboratory	Study of synchronous operation of wind power plants and grid.	1

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