TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY
Director of Power Engineering School
_____ A.S. Matveev
«30» 06 2020

Philosophical and Methodological Issues of Science and Engineering

Syllabus

Field of Study: 13.04.02 Electrical Power Engineering and Electrical Engineering

Program: Electric Power Generation and Transportation

Level of Study: Master Degree Program

Year of Admission: 2019
Year: 1
Semester: 2

ECTS: 3

Total Hours: 108
Contact Hours: 32

- **Lectures:** 16
- **Labs:** 0
- **Practical experience:** 16

Assessment: exam

Department: Division for Power and Electrical Engineering

Head of Department: Alexander S. Ivashutenko

Instructor: Olga T. Loyko

2020

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Philosophical and Methodological Issues of Science and Engineering

Course Overview

<table>
<tr><td>Course Objectives</td><td>The objectives of the course are to provide the understanding of the methodology of research work and knowledge cognition, philosophy and methodology of science and engineering.
Students will be able to apply scientific methods of solving engineering problems, select efficient ways of solving engineering problems of interdisciplinary nature.Having successfully completed the course, students will be able to apply the scientific frame of mind for understanding interconnections in the natural world, use techniques of creative problem-solving in the context of engineering.</td></tr>
<tr><td>Learning Outcomes</td><td>As a result of mastering the course, students should know major philosophical schools, tendencies and concepts of scientific research; sources of new knowledge and techniques of their processing and evaluation.

As a result of mastering the course, students should be able to use philosophical approach for comparing and contrasting similarities and differences in the development of materials, technologies and engineering devices; be capable of analyzing logical considerations and statements;
set objectives and select methods of investigations, evaluate, interpret and present the results of scientific research.
As a result of mastering the course, students should experience to have the complex scientific view of the natural world, demonstrate abilities to analyze, generalize and acquire information, set objectives and find ways of achieving them; demonstrate philosophical and methodological bases for investigations and technological research in the area of electrical engineering aimed at solving actual problems; apply scientific methods of hypothesis defining and testing, critical thinking and outcomes predicting.</td></tr>
<tr><td>Course Outline</td><td>Course refers to Master's Program. For successful mastering the course student should:
know:
basics schools of philosophical knowledge, methodology of research work and knowledge cognition, philosophy and methodology of science and engineering;
be able to:
apply scientific methods of solving engineering problems, compare and contrast similarities and differences in the development of materials, technologies and engineering; select efficient ways of solving engineering problems of interdisciplinary nature; interpret and present the results of research done;
experience to:
acquire the scientific frame of mind and understand interconnections in the complex view of the natural world; develop critical thinking skills and use techniques of creative problem-solving in the context of engineering
<table>
<tr><td rowspan="2">Modules</td><td colspan="3">Classroom activity (h)</td><td rowspan="2">Self-study (h)</td><td rowspan="2">Total (h)</td><td rowspan="2">Forms of academic progress monitoring and assessment</td></tr>
<tr><td>Lecture</td><td>Practice</td><td>Lab</td></tr>
<tr><td>1. Essence and interdisciplinary nature of modern science and technology.</td><td>6</td><td>4</td><td></td><td>24</td><td>34</td><td>Oral test
Individual task</td></tr>
</table>
</td></tr>
</table>

	2. Innovations and responsibility issues in science and engineering.	6	4		26	36	Oral test Individual task
	3. Efficient communication in science and engineering.	4	8		26	38	Oral test Individual task
	5. Interim assessment						Credit test
	Total	**16**	**16**		**76**	**108**	
Prerequisites (if available)	Basics of Philosophy						
Course *Structure*	**Module 1. Essence and Interdisciplinary Nature of Modern Science and Technology** **Lecture 1 Introduction to Philosophy of Science** Philosophy of science: definition, concepts. Carl G. Hempel and Paul Oppenheim: De Nomological (D-N) model. Verification and reasoning in science. Tests and observations in The problem of objectivity in science. Philosophy of engineering: definition, approaches, t Engineering and sciences: comparison and contrast. **Lecture 2 Major Philosophical Schools and their Influence on the Cognition Process** Karl Popper as an outstanding philosopher of science. Logical asymmetry. Hypothesis genera hypothesis testing: methods and approaches. Thomas Kuhn and his philosophical heritage: 'The Structure of Scientific Revolutions'. Bacon and his classification of sciences. Pessimistic induction in science. Understanding l nature works. **Lecture 3 Basic Questions in Science and Engineering: from Theory to Practice** Basic questions in science and engineering and how they are answered. Nature of engineering Engineering design process: aims, problems, solutions, consequences. **Practice 1 Engineering Design: from Idea to Patent** Engineering design as an art and technological process. Interdisciplinary projects: inno practicality, aesthetics, safety regulations and legitimate issues. **Practice 2 Engineering Projects: Examples of Technical Excellence** Top ten engineering projects that changed our understanding of the natural world. Case 'Falkirk Wheel, 'Panama Canal', 'The Channel Tunnel', 'Burj Khalifa'. **Module 2. Innovations and Responsibility Issues in Science and Engineering** **Lecture 4 Role of Engineering in Society** Engineering and technology in the modern world. Professional profile of modern en Requirements of leading professional engineering organizations. Engineer as a key personalit process of technological and social progress. **Lecture 5 Responsibility and Ethical Issues in Engineering** Societal and global impact of engineering solutions. Engineering ethics and its main principle of ethics in Europe and the USA. Risk-taking in engineering: benefits and deficiencies. **Lecture 6 Entrepreneurship in Engineering: Philosophical Aspect** Innovations in engineering and technology: needs and demands. Technological aspect of scie civilization. Evolution in science and engineering as a means of social progress. **Practice 3 Project Management in Engineering**						

Project management: definition, objectives, activities, procedure. Interdisciplinary projects: from innovative ideas to profitable outcomes.

Practice 4 Environmental Issues and Engineering Solutions: Setting Objectives and Finding Solutions

Use of CFCs. Global warming. Environmental pollution. Alternative fuel for automobiles. Discussion of research projects.

Module 3 Efficient Communication in Science and Engineering

Lecture 7 Philosophy of Engineering Education: Soft Skills and Competencies

Soft skills in engineering: definition, classification. Communications skills of engineers. English as *lingua franca* in international engineering projects.

Lecture 8 Liberal arts in Engineering Education

Humanities as a branch of science and scientific cognition. Liberal arts and engineering: aesthetics vs. practicality.

Practice 5 Leonardo da Vinci: artist and engineer. Inventions that have stand the time

Renaissance period and its influence on the development of sciences. Leonardo da Vinci: from inventions and painting.

Practice 6 Thomas Watt and Nicola Tesla as prominent figures in engineering that changed the technological image of the society

Inventions of Thomas Watt: social impact.
Nicola Tesla: starting the digital world and connecting people.

Practice 7 Engineering the world: role of IT and electronic gadgets

History of calculation and information retrieval: abacus vs. tablet computers.

Practice 8 Presentations of research projects

Discussion of research projects made in groups (subjects are given in Section 6.3.2. Individual and group tasks/reports).

To develop creative skills of students when doing this course a list of subjects was defined intended for *research activity, essays on the most challenging problems, theoretical and practical issues:*

- history of philosophy and outstanding philosophers;
- mainstream schools of philosophy and their influence on the development of thought and knowledge about the natural world;
- philosophy of science and engineering: definition, concepts, features;
- engineering activity and its impact on the development of human mind and social improvement;
- engineering design: concepts, approaches, consequences;
- customer-friendly product design: practicality, aesthetics, eco-friendliness;
- renewable energy sources: economical, political, ecological and social aspects;
- soft skills and continuous professional development in engineering.

6.3.2. Subjects of individual tasks (reports):

1. Darwinian selection model and its application in modern science and engineering;
2. Prominent philosophers (Plato, Aristotle, Socrates) and their theories;
3. Philosophical views of F. Bacon and their influence on the development of philosophy of science;
4. Epistemology as a science of sciences and its outstanding representatives in the 18-20th centuries;
5. PhD: history of the academic degree;
6. Engineering design: principles, methods, and application;
7. The Channel Tunnel, Burj Khalifa and Panama Canal as examples of top engineering projects;

	8. Product design and safety issues: principles, regulations, and restrictions; 9. Modern strategies in energy generation (social, political and engineering aspects); 10. Alternative fuels for automobiles: trends and perspectives; 11. Activities of Wind Energy Associations worldwide: promoting renewable energy sources; 12. Kyoto protocol and its impact on the environmental protection worldwide; 13. Climate change: tendencies, issues, ways of solving environmental issues; 14. Role of English in multinational interdisciplinary engineering projects: benefits and deficiencies; 15. Soft skills and continuous professional development as factors of successful engineering career.
Facilities and Equipment	– practical classes are conducted in specialized classrooms, computers are connected to the network of Institute of Power Engineering with access to the Internet; - lectures are held in lecture rooms with the use of technical aids; lecture material is shown in the form of Power Point presentations
Grading Policy	*In accordance with TPU rating system we use:* *Current assessment which is performed on a regular basis during the semester by scoring the quality of mastering of theoretical material and the results of practical activities (performance tests, perform tasks, problem solving). Max score for current assessment is 80 points, min - 55 points.* *Course final assessment (exam) is performed at the end of the semester. Max score for course final assessment is 20 points.* *The final rating is determined by summing the points of the current assessment during the semester and exam scores at the end of the semester. Maximum overall rating corresponds to 100 points, min pass score is 55.*
Course Policy	*Class attendance will be taken into consideration when evaluating students ' participation in the course . Students are expected to actively engage in class discussions about the assigned readings.*
Teaching Aids and Resources	Compulsory Readings: 1. Gorokhov V.G. Concepts of modern science and engineering. Moscow: 2002. 2. Ruzavin G.I. Philosophy of science. Moscow: UNITY-DANA, 2005. 400 p. 3. Styopin V.S., Gorokhov V.G., Rozov M.A. Philosophy of science and engineering. Moscow, 1996. 4. Modern philosophical issues in natural, engineering and social sciences/Ed. by Doctor of Philosophy V.V. Mironov. Moscow: Gardariki, 2007. 639 p. 5. History and philosophy of science/ Ed. by S.A. Lebedev. Moscow: Academic Prospect, Alma-Mater, 2007. *Additional Readings:* 1. http://www.raeng.org.uk/societygov/philosophyofeng/pdf/abstract_papers.pdf 2. http://sammelpunkt.philo.at:8080/1274/1/MITCHAM.pdf 3. http://www.britannica.com/EBchecked/topic/190219/epistemology 4. http://plato.stanford.edu/entries/epistemology/ 5. http://www.iep.utm.edu/epistemo/ 6. http://www.rep.routledge.com/article/P059 7. Thornton, Stephen (2006). "Karl Popper". *Stanford Encyclopedia of Philosophy*. http://plato.stanford.edu/entries/popper/. Retrieved 2007-12-01. 8. Popper, Karl (2004 reprint). *The logic of scientific discovery*. London & New York: Routledge Classics. ISBN 0-415-27844-9. 9. www.abet.org 10. www.engc.org.uk 11. Australian Engineering Competency Standards. Engineers Australia, Engineering House, 11 National Circuit Barton ACT 2600. ISBN: 0 85825 771 8 12. http://temp.onlinethics.org/cases/robot/article- 1.htm/ 13. http://iprojectideas.blogspot.com/2011/04/solar-powered-air-conditoner.html

	14. http://www.engineeringdaily.net/top-10-most-impressive-engineering-projects/ 15. http://www.ehow.com/how_5095767_write-technical-essay.html 16. http://www.bbc.co.uk/worldservice/learningenglish/business/talkingbusiness/unit3presentations/1opening.shtml
Instructor	•