AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Geothermal Energy

Academic year: 2019/2020 Code: ZSDA-3-0294-s ECTS credits: 4

Faculty of: Szkoła Doktorska AGH

Field of study: Szkoła Doktorska AGH Specialty: —

Study level: Third-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 0

Course homepage: https://geotermia.agh.edu.pl/

Responsible teacher: dr hab. inż. Śliwa Tomasz (sliwa@agh.edu.pl)

Module summary

The student will learn the basic definitions related to geothermal energy. He will learn the origin of the Earth's heat. Will know how to look for geothermal heat resources, how to make them available, exploited and what are the possibilities of its use, mainly in the energy sector.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	The student has the competence to discuss energy saving, renewable energy sources, environmental protection for future generations, economics in the aspect of energy and environmental protection	SDA3A_K01, SDA3A_K03, SDA3A_K02	Activity during classes
Skills: he can			
M_U001	Ability to search and share geothermal energy	SDA3A_U01	Test
M_U002	Ability to design exploitation and utilisation of geothermal energy	SDA3A_U07, SDA3A_U03, SDA3A_U02	Test
Knowledge: he knows and understands			
M_W001	Knowledge of basic concepts and definitions in the field of geothermal energy	SDA3A_W01	Examination
M_W002	Knowledge of the origin of the Earth's heat and conceptions of energy on Earth and in Universum	SDA3A_W02, SDA3A_W05, SDA3A_W04	Examination

Number of hours for each form of classes

	Form of classes										
Suma	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
45	15	15	0	15	0	0	0	0	0	0	0

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	The student has the competence to discuss energy saving, renewable energy sources, environmental protection for future generations, economics in the aspect of energy and environmental protection	-	-	-	+	-	-	-	-	-	-	-
Skills: he can												
M_U001	Ability to search and share geothermal energy	-	+	-	-	-	-	-	-	-	-	-
M_U002	Ability to design exploitation and utilisation of geothermal energy	-	+	-	+	-	-	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	Knowledge of basic concepts and definitions in the field of geothermal energy	+	-	-	-	-	-	-	-	-	-	-
M_W002	Knowledge of the origin of the Earth's heat and conceptions of energy on Earth and in Universum	+	-	-	-	-	-	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	45 h
Preparation for classes	10 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	25 h
Realization of independently performed tasks	15 h
Examination or Final test	2 h
Contact hours	5 h
Summary student workload	102 h
Module ECTS credits	4 ECTS

Additional information

Module content

Lectures

Geothermal Energy

Definitions of geothermal heat, geothermal resources, geothermal gradient, geothermal grade, geoenergetics and underground thermal energy storage. Genesis of the Earth’s heat against the background of energy genesis. Geothermal areas. Geothermal energy in sedimentary basins. Geothermal holes, geothermal doublets. Corrosion of geothermal waters. Fiberglass casing. Drilling geothermal boreholes. Borehole heat exchangers. Geothermal heat pumps. Profitability of geothermal investments. Geothermal energy in Poland, in the European Union and in the world. The use of geothermal heat. Electricity generation. Geothermal pools.

Auditorium classes

Geothermal doublets. Borehole heat exchangers. Geothermal heat pumps

Calculation of geothermal doublets. Heat losses calculations. Borehole heat exchangers efficiency calculation. Borehole heat exchangers fields. COP of geothermal heat pumps. Determining the heating power. Profitability assessment of geothermal doublets and geothermal heat pumps.

Project classes

Project of making available, exploitation and use of geothermal energy

Design of the borehole exploiting geothermal waters. Injection borehole design. Calculating the distance between boreholes of doublet .
Borehole heat exchangers field project. Hydrogeological documentation. Economic analysis.

Teaching methods and techniques:

Lectures: Lecture and multimedia presentations
Auditorium classes: Calculation, discussion, presentations, home works
Project classes: Geothermal boreholes design. Design of borehole heat exchangers. Designing of borehole heat exchanger fields.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:

Completing the tutorials based on the result of the test and class participation and activity on classes. Project defense. Two colloquium and project corrections are allowed. Students who have at least a satisfactory grade (3.0) from other classes can be qualified to the exam.

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:

Lectures:
– Attendance is mandatory: Yes
– Participation rules in classes: Class attendance
Auditorium classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Class attendance
Project classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Class attendance

Method of calculating the final grade

Final grade = 50% of the exam grade + 25% of the tutorial grade + 25% of the project tutorial mark (of the project grade)

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:

Individual discussion and supplementation of material from students present in class

Prerequisites and additional requirements

Knowledge of geology, mining, thermodynamics, chemistry, economics

Recommended literature and teaching resources

William E. Glassley, Geothermal energy : renewable energy and the environment, CRC Press, 2010.

David R. Boden, Geologic fundamentals of geothermal energy, CRC Press – Taylor & Francis Group, 2017.

Mary H. Dickson and Mario Fanelli, Geothermal energy : utilization and technology, London, Earthscan, 2005.

Ingrid Stober, Kurt Bucher, Geothermal energy : from theoretical models to exploration and development, Berlin, Heidelberg, Springer-Verlag, 2013.

Marc A. Rosen and Seama Koohi-Fayegh, Geothermal energy : sustainable heating and cooling using the ground, Chichester, John Wiley & Sons, 2017.

Scientific publications of module course instructors related to the topic of the module

1.Tomasz Śliwa: Analysis of a heat pump system based on borehole heat exchangers for a swimming pool complex in Krynica, S-Poland; Geothermal Training in Iceland; Reports of the United Nations University Geothermal Training Programme, Reykiavik, 1999, pp. 357-383.

2.Andrzej Gonet, Tomasz Śliwa: The utilisation of boreholes for geothermal heat exploitation, Nové poznatky v oblasti vrtania, tazby, dopravy a uskladnovania uhl’ovodíkov, Zborník prednások XI. Medzinárodná Vedecko-technická Konferencia, Technická Univerzita v Kosiciach. Fakulta Baníctva, Ekológie, Riadenia a Geotechnológií. Katedra Ropného Inzinierstva, Podbanské, Slovensko 29-31

października 2002, pp. 38-41.

3.Gonet Andrzej, Stanisław Stryczek, Tomasz Śliwa, Jan Kruczak, Jan Woliński (2003), Specificity of geothermal drilling based on Oil and Gas Exploration Company Jasło activities, 50 years University of Mining and Geology “St. Ivan Rilski”’ (1953—2003), Jubilee International Scientific Session, Annual of the Universtity of Mining and Geology “St. Ivan Rilski”, Sofia. Pt. 1: Geology and Geophysics; vol. 46, Publishing House “St. Ivan Rilski”, Sofia, pp. 431-434

4.Śliwa Tomasz, Jarosław Kotyza (2003), Application of existing wells as ground heat source for heat pumps in Poland, Applied Energy, vol. 74, Elsevier, pp. 3-8

5.Śliwa Tomasz, Andrzej Gonet (2003), The idea of utilising old production wells for borehole heat exchangers in the near depleted oil field in Iwonicz Zdrój, International Geothermal Conference on “Multiple Integrated Uses of Geothermal Resources”, Reykjavik, Session 13, s. 16–22

6.Śliwa Tomasz, Andrzej Gonet (2005), Theoretical model of borehole heat exchanger, Journal of Energy Resources Technology, vol. 127 no. 2, pp. 142–148

7.Gonet Andrzej, Tomasz Śliwa, Stanisław Stryczek (2005), Heating agent pressure losses in a borehole heat exchanger, World Geothermal Congress 2005, WGC 2005 ``Geothermal energy: the domestic, renewable, green option’’, Antalya, Turkey, 24–29 April 2005 : proceedings. eds. Roland Horne, Eder Okandan ; IGA International Geothermal Association, TGA Turkish Geothermal Association, IGA, p. 1–7 referat

8.Śliwa T., Gołaś A., Wołoszyn J., Gonet A. (2012), Numerical model of borehole heat exchanger in ANSYS CFX software (Numeryczny model otworowego wymiennika ciepła w pakiecie ANSYS CFX), Archives of Mining Sciences (Archiwum Górnictwa), vol. 57 no. 2 pp. 375–390

9.Sliwa T., Rosen M.A. Jezuit Z. (2014), Use of Oil Boreholes in the Carpathians in Geoenergetic Systems: Historical and Conceptual Review, Research Journal of Environmental Sciences, vol. 8 iss. 5, s. 231-242

10.Śliwa T., Rosen M.A. (2014), Natural and artificial methods of heat resources regeneration in underground thermal energy storages with borehole heat exchangers, Conference proceedings paper, The 4th world sustainability forum, 1–30 November, s. 1–15

11.Śliwa T., Rosen M.A., Natural and artificial methods for regeneration of heat resources for borehole heat exchangers to enhance the sustainability of underground thermal storages: a review, Sustainability 2015 vol. 7 iss. 10, p. 13104-13125

12.Sapińska-Śliwa A., Rosen M.A., Gonet A., Śliwa T., Deep borehole heat exchangers – a conceptual and comparative review, International Journal of Air-Conditioning and Refrigeration, 2016 vol. 24 iss. 1 art. no. 1630001, s. 1–15

13.Śliwa Tomasz, Sojczyńska Anna, Rosen Marc A., Kowalski Tomasz, Evaluation of temperature profiling quality in determining energy efficiencies of borehole heat exchangers, Geothermics, 2019, vol. 78, pp. 129–137

Additional information

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