Universidad Zaragoza

Academic Year/course: 2021/22

60379 - Geothermics and its applications

Syllabus Information

Academic Year: 2021/22
Subject: 60379 - Geothermics and its applications
Faculty / School: 100 - Facultad de Ciencias
Degree: 624 - Master's in Geology: Techniques and Applications
ECTS: 3.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

1. To understand planetary-scale thermal energy flow and its effects on the Earth's surface when this heat flow interacs with groundwater, generating a geothermal system.
2. To understand how a geothermal system works and the different types of geothermal systems.
3. To learn the different uses of geothermal energy and the environmental impacts associated with them.
4. To learn the existing methodologies of geothermal exploration.
5. To estimate the geothermal potential of an area, the environmental implications, and the economic dimension.

These objectives are in the line of the following Sustainable Development Goals of the UN 2030 Agenda (https://www.un.org/sustainabledevelopment/):

SDG 4: Quality Education

SDG 7: Affordable and Clean Energy

SDG 9: Industry, Innovation and Infrastructure

SDG 11: Sustainable Cities and Communities

SDG 12: Responsible consumption and production

SDG 13: Climate Action

in such a way that the acquisition of the knowledge given in this course provides the ability and competence to contribute to their achievement.

1.2. Context and importance of this course in the degree

This course is part of the optional block of MSc courses, all of them taught during the second semester.

The course contents assumes that the student has a basic understanding of the Earth as a dynamic planet, specially of those topics connected with the flow of heat in the Earth's crust and with the movement of groundwater. However, the priority of this course is the application of this theoretical framework to the assessment of geothermal resources. This is why the course is focused on the characterisation of the different types of geothermal systems, the study of the possible uses of this energy and its environmental impact, the exploration and discovery of new resources, and the evaluation of the geothermal resources of specific areas.

In this sense, the course fits perfectly in the general philosophy of the MSc, with a clear bias towards technics and applications. Among the applications of Earth Sciences studies, the assessment of the geothermal resources of a region is a growing area of research and development.

1.3. Recommendations to take this course

The course integrates theory classes, practical sessions and seminars in four-hour teaching sessions, and has been designed to be taught in continuous assessment mode. Thus, it is highly desiderable that the student adopts a constant and continuous work plan in order to be able to follow the course and its learning curve.

It is recommended that student refresh their knowledge on heat and water transport mechanism, at least in a qualitative way.

2. Learning goals

2.1. Competences

CB6 - To have a knowledge base which provides the ground or opportunity to be innovative in the development and/or application of ideas, often in a research-based context.

CB7 - To have the ability to apply the acquired knowledge and problem solving capabilities in new or little-known environments in larger (or multidisciplinary) contexts related to geothermal research.

CG2 - To exchange and discuss information from different sources (written, oral, numerical, graphical).

CT1 - To use the English language to obtain information and to transmit it.

CT2 - To manage and select suitable sources of bibliographic information.

CE1 - To develop the skills of analysing and synthesising geoscientific information in a critical way.

CE2 - To have the ability to integrate evidences in order to propose and test hypothesis using the scientific method in the context of the geological research.

2.2. Learning goals

- Quantify the most important processes in a geothermal system, both physical (conduction and convection heat transport) and chemical (composition of geothermal waters).
- Know the different types of geothermal systems, their energy uses and their environmental impacts.
- Apply the theoretical background to practical problems in relation with the geothermal exploration and the evaluation of the geothermal potential of a region.

2.3. Importance of learning goals

The study of geothermal resources has a theoretical and an applied side. The applied side aims at the exploitation of Earth's internal heat given specific thermal properties of underground rocks and waters, both for the generation of electricity or for direct use of this heat (for central heating, greenhouse heating, aquaculture, thermal spas, underground thermal energy storage, and many other industrial and agricultural uses). Geothermal energy is a clean and renewable energy source with an increasing demand in our society. Thus, it is important that the student is able to assess the geothermal potential of a region, something that this course has as one of its core objectives.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

To track the learning curve of the students, part of the assessment will be carried out during the learning process (continuous assessment) and part at the end of the course (final assessment).

Continuous assessment

- Assessment of learning task 1 (lecture/presentation). Written exams at the end of each of the three course units (20% of grade).

- Assessment of learning task 2 (lab sessions and case studies). Written report of each practical session, due one week after the practical session (50% of grade).

- Assessment of learning task 3 (seminars). Individual and/or group reports (30% or grade).

The final mark is computed as the weighted average of each learning task, provided each one is equal or greater than 5.

Final Assessment

For those students that did not pass the course by continuous assessment a final theory and practice written exam must be taken, where the same learning goals as in the continuos assessment will be evaluated. The written exam could also include an essay part on specific scientific papers, which details will be given to the students at least one week before the examination date.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The course is organised around three learning tasks:

Lectures/presentations: 1.4 credits.

Practice sessions (including computer sessions) and case studies: 1.2 credits

Seminars: 0.4 credits.

Each of these learning tasks is detailed in the following section.

4.2. Learning tasks

Learning task 1: lectures/presentations. Twelve face to face hours. This activity is designed to present and explain the theoretical background of the course.

Learning task 2: practice sessions and case studies. Twelve face to face hours. During the practical sessions specific examples and case studies will be presented to the student in the field of geothermics. In the computer sessions both specific and general-purpose software will be used in order to solve more complex problems than in the lab sessions.

Learning task 3: seminars. Four face to face hours. In this activity the students will be presented in advance with specific cases of geothermal systems in order to discuss the topic during the seminar based on short presentations by the students followed by a debate.

Learning task 4: Student personal work (45 off site hours). Time required by the student to the study of the theoretical concepts, finish the lab reports, and prepare seminar presentations.

Note: the teaching and evaluation activities will be carried out on-site unless, due to the Covid-19 health situation, the provisions issued by the competent authorities and by the University of Zaragoza require them to be carried out online or mixed on-site-online with reduced-capacity rotating groups. Online teaching will not be applied to field practices.

4.3. Syllabus

Theoretical programme:

Topic 1: Fundamentals of geothermics

Topic 2: Classification of geothermal systems

Topic 3: High temperature hydrothermal systems

Topic 4: Petrothermal systems (Enhanced Geothermal Systems)

Topic 5: Medium-low temperature hydrothermal systems (Geothermal Heat Pumps).

Topic 6: Exploration and discovery of geothermal systems.

Topic 7: Resource assessment.

Topic 8: Environmental aspects of using geothermal energy.

Practical sessions programme:

Practical session 1: Construction of heat flow maps.

Practical session 2: EGS potential in Spain.

Practical session 3: Geothermometric calculations

Practical session 4: Heat flow calculation in Aragonian thermal springs.

Seminar: Evaluation of the use of geothermal energy worldwide.

4.4. Course planning and calendar

The course is taught during the second semester in four-hour sessions that combine lectures and practices and has a duration of 7 weeks. Class schedule will be announce well in advance and published in the web page of the Faculty of Sciences (https://ciencias.unizar.es/calendario-y-horarios). Final examination dates will also be announced in advance and published in the same web page.

Key dates

Beginning of the course: first week of February, in accordance with the Faculty of Sciences academic year calendar (https://ciencias.unizar.es/sites/ciencias.unizar.es/files/users/fmlou/pdf/acuerdosjuntafacultad/calendario_acad_f_ciencias_2020

Lab reports deadlines: as a rule, one week after the practical session.

Final written exam: at the end of the semester, in accordance with examination calendar of the Faculty of Sciences (https://ciencias.unizar.es/calendario-y-horarios).

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=60379