COURSE PROPOSAL – AUTUMN 2021

**Title: Enhancing datasets management with SQL**
Lecturer: dr inż. Piotr Klejment
Course block: IT Tools (facultative)
Credits: 10h/1ECTS
Pass: Exam/Project

REQUIREMENTS
general computer literacy is recommended

GENERAL DESCRIPTION
In geophysics, as in other fields of natural science, huge amounts of data are stored in databases. A working knowledge of SQL (Structured Query Language) can facilitate extraction of data and is very useful in all kind of data science operations. SQL is very practical and easy to use, created especially to design and manage relational databases (relational systems are made up of a set of tables containing rows and columns of data). Even with no background in programming, it is possible to master the fundamentals of the language. The purpose of this course is to introduce relational database concepts and to apply SQL from foundations to intermediate issues.

COURSE OUTLINE
Introduction to relational databases and tables: basic SQL statements, fundamental concepts behind databases, tables, and the relationships between them, analyzing data using aggregate functions with GROUP BY commands, JOIN commands and others.

Intermediate SQL: sorting and grouping data in result sets, composing nested queries, access to data from multiple tables, running advanced queries with string operations and comparison operations, adding logical operators to SQL queries.

Accessing databases using Python: basic concepts related to using Python to connect to databases, creating tables, loading data, querying data, and analyzing data using Python.

**Title: Opportunities for funding and networking for young researchers**
speaker: Michael Nones, chair MCAA Poland chapter.
course block: practical classes (facultative)
credits: 4h/1ECTS
pass: attendance

The seminar will be divided into two parts. The topics will be of interest for students willing to continue their research career in Europe, and be engaged in high-level associations.
The first part will be focused on presenting current and future opportunities for young researchers to fund their research at both European (e.g., ERC, MSCA) and Polish (e.g., NCN, NAWA) level.
The second part will be devoted to present the Marie Curie Alumni Association, and its Polish chapter, pointing out its role in foster soft skills and networking of its alumni.

**Subject: Mild Introduction to Complex Systems**
Lecturer: dr hab. Mariusz Białecki, prof. IGF PAN
Course block: general/monographic/interdisciplinary/optional
Credits: 30 h / 3 ECTS (10 lectures)
Pass: Attendance and a short written study on a selected topic in line with the student's specialization

Description:
The lecture course introduces on elementary level fundamental concepts of complex systems, that proved to be indispensable for proper understanding numerous natural phenomena of modern interest.

The world is complex, thus strategies based on simple assumptions – like linear, Gaussian, small-scale – are just not sufficient nowadays. Unfortunately, students in classical education are very rarely introduced to knowledge of nonlinear, non-Gaussian, large coupled spatial systems.

This lecture course is aiming at filling the gap by providing a complex system toolbox for modern research. The following mathematical topics will be introduced and discussed: fundamentals of dynamical systems (including: randomness, correlations, stationarity), linear systems (incl.: modes, system coupling, control), nonlinear dynamics (incl.: bifurcations, hysteresis, catastrophes), spatial systems (incl.: discretization, agent models, cellular automata), power laws and complex systems (incl.: phase transitions, criticality, emergence).

The way of presentation focuses on conceptual description of phenomena, rather than on technical or detailed calculations in order to enable grasping a big picture of interesting issues. For complimentary, more detailed and mathematically involved treatment of selected techniques we refer to the course "Introduction to Nonlinearity". (I encourage to study both!)

**Subject title: Introduction to Nonlinearity**
Lecturer: dr hab. Mariusz Białecki, prof. IGF PAN
Course block: general/monographic/interdisciplinary/optional
Credits: 30 h / 3 ECTS (10 lectures)
Pass: Attendance and a short written study on a selected topic in line with the student's specialization

Description:
The aim of the lecture course is to provide to a student a “reference catalogue of examples” how to deal with nonlinear description of phenomena in everyday research practice.

The lecture course introduces comprehensively various properties of nonlinear systems by discussing selected examples in detail. Those examples are taken from the mathematics itself (ODE, nonlinear maps, solitons) as well as from natural sciences (mechanical and physical systems, biological systems, epidemic models), and may be (slightly) adjusted according to the audience’s interest.

The way of presentation focuses on mathematical aspects and techniques of presented material, thus require interest in analytical description. However, to keep the contents approachable for students from various disciplines, all necessary non-standard mathematical concepts will be clearly introduced and discussed. For complimentary, more general view of manifestations of various nonlinear properties we refer to the course “Mild Introduction to Complex Systems”. (I encourage to study both!)

Title: **Seismology and active seismic**
30h of lecture with numerical classes in winter semester 2021/2022
Time: Wednesday 14:00-16:00, Physics Department building, Pasteura 5 (room – to be decided)
Lecturer: dr hab. Mariusz Majdański
classes: mgr Artur Marciniak

**Short description**: Lecture shows seismic waves as a source of information of Earth structure, with Focus on the lithosphere

**Detailed description:**

**1. Characteristics of continous medium**

Elastic parameters; rock density and porosity; seismic velocity anisotropy; elastic properties of rocks at high pressures and temperatures.

**2. Seismic waves**

Theoretical basics; the equation of an elastic medium; P and S volume waves; surface waves; ray based method in multilayer media; theoretical hodographs, amplitudes and synthetic seismograms.

**3. Ray theory and inversion of travel times**

Parametric equation of the wave hodograph; Jeffreys-Bullen hodograph; Snelius 'Law, Huygens' Principle; ray tracing method; inversion, linearization and regularization, solution inaccuracy

**4. Structural seismology**

The structure of the Earth's crust and upper mantle; refraction method; deep seismic soundings; explosion seismology; seismic tomography.

**5. Seismic**

Assumptions of reflection seismic, industrial methods, near-surface research, analysis of surface waves

Estimated, total number of hours that the student must spend on achieving the learning outcomes defined for the subject (taking into account the organized hours, methods, student's independent work) - adequate to the student's ability, willingness and commitment.
It is recommended to pass the lecture with elements of continous medium mechanics earlier. Before starting the course, the student should have the basics of continous medium mechanics, wave physics and basic programming skills.

**Literature:**

The lecture presents the latest achievements of Earth sciences, including those unavailable in academic books. Therefore, conscious participation in the lectures is highly recommended. Literature required or recommended for the final exame of the course concerns "classical" issues and may help in revising the lecture material. As the subject ends with an examination, this is also the recommended literature for the examination.


- K. Aki & P.G. Richards (2005), Quantitative Seismology: Theory and Methods
- P. Shearer (2009), Introduction to seismology
- O. Yilmaz (2001), Seismic data analysis: Processing, Inversion and interpretation of seismic data
- Majdański M, Grad M, Guterch A, SUDETES 2003 Working Group 2006 2-D seismic tomographic and ray tracing modelling of the crustal structure across the Sudetes Mountains basing on SUDETES 2003 experiment data. Tectonophysics 413:249-269
- Majdański M, Trzeciak M, Gaczyński E, Maksym A (2016) Seismic velocity estimation from postcritical wide-angle refelctions in layered structures. Stud.

Geophys. Geod., 60:565-582.

- Lowrie, W. (1997). Fundamentals of Geophysics. Cambridge: Cambridge University Press.

**Lecture effects:** The assumed effect of learning is to obtain knowledge about seismology - in terms of the use of seismic waves to study the structure of the Earth. After completing the lecture, the student analyzes, recognizes and explains phenomena from the physical point of view.

**Evaluation methods**: Verification and assessment of the learning outcomes achieved by the student, specified for the subject as a whole, takes place as a result of the examination process for each student participating in the above didactic subject.
Credit for the grade is done by completing tasks during exercises and in the form of an oral exam.

**Title: Anthropogenic seismicity**

*Lecturer: prof. Beata Orlecka-Sikora*

Components: Lectures

Description:

This course will introduce students to the problem of seismicity associated with the exploitation of geo-resources. We will discuss different geo-resource exploitation technologies that may induce seismicity and the mechanisms of interaction between technological activity and the rock mass. We will determine the necessary conditions to identify earthquake as an induced, triggered, or natural. Students will learn about the vital properties of anthropogenic seismicity. They will also learn what kind of scientific tools may be applied to assess the hazard they pose. Finally, they will learn about the international collaborative undertakings for research into anthropogenic seismicity.

*Prerequisites: Elementary knowledge of physics, geophysics and seismology are desirable*

Time Schedule:

| Course Title | Course Duration (hrs)<br>T-Theory, P-Practice |
|---|---|
| 1) Anthropogenic seismicity. Mechanisms of interaction between technological activity and the rock mass. Examples | T: 2h |
| 2) Induced, triggered or natural? Socio-economic impact of anthropogenic seismicity | T: 1h |
| 3) Vital properties of anthropogenic seismicity and examples of recent scientific findings in this regard | T: 1h |
| 4) Some parameters and methods used to assess seismic hazard of anthropogenic seismicity | T: 2h<br>P: 1h |
| 5) Collaborative undertakings for research into anthropogenic seismicity | T: 1h |
| | |
| TOTAL | **8h (T:7h – P:1h)** |

**Title: Seismological Data – seismic networks, available formats and catalogue description**
*Lecturer: Łukasz Rudziński*

Description:
The courses will provide to the students the advanced information concerning data which are typical for seismological studies. After the courses, the students will be familiar with seismic networks and type of instruments which are used in seismological monitoring. We will introduce different seismic formats and provide practical exercises with data conversion. Basic seismogram analysis and how they are related to seismological investigations will be explained. Finally, students will know what is a seismic catalog. We will discuss, which kind of information are included in catalog and how a catalog can be used in different seismological problems. The subjects that are going to be addressed during the courses are:

1. Seismic networks and seismic instruments,
2. Signal formats in seismology and practical conversion among them,
3. Basic seismograms analysis with practice,
4. Catalog in seismology and how it is related to different seismological problems.

*Prerequisites: Elementary knowledge of mathematics, Linux, Python and Seismology is desirable*
Time Schedule:

| Course Title | Course Duration (hrs)<br>T-Theory, P-Practice |
|---|---|
| 6) Seismic networks and seismic instruments | T: 2h<br>P: 1h |
| 7) Signal formats in seismology and practical conversion among them | T: 2h<br>P: 2h |
| 8) Basic seismograms analysis with practice | T: 2h<br>P: 1h |
| 9) Catalog in seismology and how it is related to different seismological problems | T: 2h<br>P: 1h |
| 10) Additional exercises | T: 0h<br>P: 2h |
| TOTAL | **15h (T:8h – P:7h)** |

**Title: Contmeporary geophysics - Introduction to Seismology**
Lecturer: dr hab. Grzegorz Lizurek
Type: Lecture/tutorials
Course block: general/monographic/interdisciplinary/optional
Credits: 12 h / 1 ECTS
Pass: Exam

Description:
Introduction to seismology is aimed to allow PhD students to understand basics of modern seismology research topics and seismic hazard. It will be mainly based on the seismic wave physics and how we process data to properly locate earthquakes, how we calculate the magnitude and other dynamical parameters as well as what is focal mechanism concept and its relation to tectonics. It will also introduce to seismic hazard assessment in tectonic and anthropogenic seismicity. This course is planned as a lectures with some exercises based on e-research platform EPISODES https://tcs.ah-epos.eu/ were real data and modern research software is available.

**Tytuł wykładu:** Teoria dynama hydromagnetycznego w geo- i astrofizyce 1
**Ilość godzin:** 30h wykładu i 30h ćwiczeń; **semestr zimowy (cz. 2 w semestrze letnim)**.
**Język wykładu:** z założenia angielski, jeśli jednak będą tylko studenci polskojęzyczni, to wykład poprowadzę po polsku.
Wykład: dr hab. Krzysztof Mizerski, ćwiczenia: dr Marek Grądzki.

1. Historia teorii opisujących generację pola geomagnetycznego.
2. Dynamo ziemskie w porównaniu z dynamem na innych obiektach układu Słonecznego (Słońce, Merkury, Wenus, księżyc Jowisza Io, Jowisz oraz Mars, Księżyc w przeszłości). Dlaczego Ziemskie dynamo jest wciąż tak efektywne?
3. Równania Magnetohydrodynamiki
    a. Równanie Naviera-Stokesa z siłą Lorentza
    b. Równania Maxwell'a
    c. Wyprowadzenie równania indukcji pola magnetycznego
    d. Twierdzenie Helmholtza o wmrożeniu pola magnetycznego.
    e. Twierdzenie Taylora-Proudmana
4. Mechanizmy generacji pola
    a. Efekt Omega i efekt alpha – teoria pola średniego.
    b. Dynamo typu alpha-Omega oraz alpha^2
    c. Niestabilności magnetyczne – niestabilność magnetorotacyjna oraz niestabilność wyporności magnetycznej w kontekście Tachokliny słonecznej.
    d. Niestabilność pływowa (źródło pola magnetycznego na Io).

Na ćwiczeniach rozwiązywane będą problemy wprowadzające oraz uzupełniające wiedzę na temat ww. aspektów dynama hydromagnetycznego, w tym przy użyciu pakietów MATLAB oraz MATHEMATICA. Ćwiczenia będą się odbywały częściowo przy tablicy (rozwiązywanie prostych przykładów), ale w większości przy komputerze (programowanie przy użyciu ww. pakietów).

**Wymagania:**
1. Znajomość podstawowej algebry, pojęcia pochodnej.
2. Podstawowa umiejętność rozwiązywania równań różniczkowych.
3. Podstawowa wiedza z elektromagnetyzmu i rachunku wektorowego.

**Warunki zaliczenia:**
Na zaliczenie będzie trzeba wykonać jedno semestralne zadanie. Tematy tych zadań podam na pierwszym wykładzie – będą tematy do wyboru. Niektóre będą opisowe, inne bardziej matematyczne. Ponadto wymagane będzie zaliczenie egzaminu ustnego.

**Literatura:**
Wykład będzie autorski i jego celem będzie przedstawienie skomplikowanych zagadnień dotyczących dynama hydromagnetycznego w przystępnej formie. Dlatego nie ma jednego podręcznika, jednak literatura polecana obejmuje (zostanie rozesłana studentom w formie elektronicznej):

[1] P. Roberts 1967, An introduction to magnetohydrodynamics, American Elsevier Pub. Co.
[2] H.K. Moffatt and E. Dormy 2019, Self-exciting fluid dynamos, Cambridge University Press,
[3] K.A. Mizerski 2021, Foundations of Convection with density stratification, Springer
[4] IUGG, 2020, Geomagnetism, Aeronomy and Space Weather, Eds. M. Mandea, M. Korte, A. Yau, E. Petrovsky, Cambridge University Press.