The Hebrew University of Jerusalem

Syllabus

Statistical mechanics of spin glasses and neural networs - 77995

Last update 05-08-2015

HU Credits: *4*

Degree/Cycle: *2nd degree (Master)*

Responsible Department: *physics*

Academic year: *0*

Semester: *2nd Semester*

Teaching Languages: *Hebrew*

Campus: *E. Safra*

Course/Module Coordinator: *Prof Haim Sompolinsky*

Coordinator Email: *haim@fiz.huji.ac.il*

Coordinator Office Hours: *By appointment*

Teaching Staff:
Prof Haim Sompolinsky

Course/Module description:
Advances in the theory of statistical mechanics of random systems have generated deep insight into the collective properties of complex systems. Spin glass theory, random matrix theory and graph theory have found applications in optimization problems, complex networks and in particular neural networks. The course will survey advanced theoretical approaches and computational methods applied in the study of complex systems and in particular in spin glasses and neural networks.

Course/Module aims:
(1) Familiarize the students with statistical mechanics approaches to spin glasses, neuronal networks and other complex systems.
(2) Provide them with the analytical and computational methods relevant to the study of these systems.

Learning outcomes - On successful completion of this module, students should be able to:
Students who successfully complete the course will master understanding of modern statistical mechanics as applied to spin glasses and neuronal networks and will acquire the analytical and computational skills of solving contemporary research problems in this field.

Attendance requirements(%):
75

Teaching arrangement and method of instruction: Frontal lectures and homework assignments.

Course/Module Content:
General: The purpose of the course is to survey advanced theoretical approaches and computational methods applied in the study of complex systems, originating from the theory of spin glasses, random matrices and random networks. Applications to the physics of spin glasses, to neural networks, as well as to social networks and artificial data processing systems will be discussed.

Topics include:

1. Spin glasses: experimental phenomenology and the Edwards-Anderson model.
2. The replica method and the mean field theory of spin glasses
3. The Potts glass.
4. The Bethe Lattice and the Message Passing method
5. Dynamic mean field theory
6. Random matrix theory for symmetric and non-symmetric networks
7. Chaos in random neural networks
8. Community detection in networks with application to social and neuronal connectomics
9. Compressive sensing systems
10. Statistical mechanics of Learning

Required Reading:
None

Additional Reading Material:
Background reading material will be provided for each topic.

Course/Module evaluation:
End of year written/oral examination 0 %
Presentation 0 %
Participation in Tutorials 75 %
Project work 0 %
Assignments 25 %
Reports 0 %
Research project 0 %
Quizzes 0 %
Other 0 %

Additional information:
The course is suitable for graduate students in physics, computer science and brain sciences. Lectures will be given twice a week (each for two hours). Grades will be given on the basis of homework assignments. Participation in lectures is mandatory