האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

# *The Hebrew University of Jerusalem*

## *Syllabus*

# *Advanced analytical mechanics - 77966*

*Last update 05-03-2019*

*HU Credits: 3*

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

*Responsible Department: Physics*

*Academic year: 0*

*Semester: 2nd Semester*

*Teaching Languages: Hebrew*

*Campus: E. Safra*

*Course/Module Coordinator: Dr. Ido Barth*

*Coordinator Email: ido.barth@mail.huji.ac.il*

*Coordinator Office Hours: By appointment*

*Teaching Staff:*

*Dr. Ido Barth*

*Course/Module description:*
*Advanced course in analytical mechanics*

*Course/Module aims:*
*1. To deepen the theoretical understanding of nonlinear multidimensional Hamiltonian systems.*
*2. To provide applicable knowledge in perturbation theories and in numerical methods for dynamical systems.*

*Learning outcomes - On successful completion of this module, students should be able to:*
*1. To analyze Hamilonian systems by the means of action-angle variables.*
*2. To identify symmetries, topology, constants of motion, and adiabatic invariants.*
*3. To use perturbation theories for solving stationary, dynamical, and resonant problems.*
*4. To write a symplectic scheme for numerical simulations of dynamical systems.*

*Attendance requirements(%):*
*0*

*Teaching arrangement and method of instruction: Lecture, exercise, and homework*

*Course/Module Content:*
*1. A review of the formalisms of Lagrange, Hamilton, and Hamilton-Jacobi.*
*2. Dynamics in phase space, Liouville theorem, and Poisson brackets.*
*3. The variational principle, canonical transformations, action-angle variables, adiabatic invariants, and phase space topology.*
*4. Integrability, Symmetry, and constants of motion.*
*5. Canonical perturbation theory, time dependent perturbation theory, averaging methods.*
*6. Nonlinear oscillator, nonlinear resonance, autoresonance, three wave interaction, and parametric resonance.*
*7. Chirikov resonance-overlap criterion, Arnold diffusion, nearly integrable systems, KAM theorem, Poincare map, Stochasticity, and chaos.*
*8. Symplectic schemes for numerical simulations of dynamical systems.*

*Required Reading:*
*non*

*Additional Reading Material:*
*• H. Goldstein, Classical mechanics, (Pearson 2013).*
*• L.D. Landau and E.M. Lifshitz, Mechanics, (Addison–Wesley 1960).*
*• A.J. Lichtenberg and M.A. Lieberman, Regular and stochastic motion, (Springer 1983).*
*• R.Z. Sagdeev, D.A. Usikov, and G.M. Zaslavsky, Nonlinear physics - from the pendulum to turbulence and chaos, (Harwood 1988).*

*Course/Module evaluation:*
*End of year written/oral examination 0 %*
*Presentation 0 %*
*Participation in Tutorials 0 %*
*Project work 100 %*
*Assignments 0 %*
*Reports 0 %*
*Research project 0 %*
*Quizzes 0 %*
*Other 0 %*

*Additional information:*
*non*