## Relação de Disciplinas

41010020 **Programa de Pós-Graduação em Física ME**

| Disciplina | Nome da Disciplina | Créditos T | TP | P | Situação |
|---|---|---|---|---|---|
| **FSC410123** | **TÓPICOS ESPECIAIS EM FÍSICA A: Advanced Classical Mechanics** | 4 | 0 | 0 | Ativo |

The goal of the course is to give students a basic knowledge of the classical mechanics concepts in the Lagrange and Hamilton formulation in connection to the field theory and relativity. Students are supposed to learn how to analyse difficult mechanical problems from the first symmetry principles, to recognise similarities between different problems, common symmetries, to absorb and to classify this information independently and to apply it in practical problems solving.
Course contents and learning outcomes

- D'Alembert and Hamilton's principles, Lagrange equations, conservation laws and systems with constraints.
- Central force problem for two and three bodies, classification and stability of orbits, Kepler problem and scattering.
- Rigid body motion, kinematics, moments of inertia and principal axes of the rigid body,
Euler's equations.
- Hamilton equations, Hamiltonian, canonical transformations and principle of least action.
- Fundamental Poisson brackets, constants of motion and Liouville's theorem.
- Hamilton-Jacobi equation, Hamilton's principal function, separable systems and actionangle
variables.
- Time-dependent and time-independent perturbation theories, adiabatic invariance.
- Lagrange and Hamiltonian formulation of continuous systems, Noether's theorem.

After the course is completed, the students should be able:
- to describe the D'Alembert and Hamilton's principles
- to apply the Lagrange formalism to the Kepler motion
- to derive a Hamiltonian governing the motion of a given mechanical system
- to derive and solve the Lagrange equations of motion for a given rigid body
- to connect symmetries of a given system with its conserved integrals of motion
- to formulate the basics of the Hamilton formalism and the principle of least action
- to relate the Lagrangian and Hamiltonian formulations and determine key differences
between them
- to classify possible types of canonical transformations
- to determine if a given transformation is canonical or not
- to explain the physical meaning of the Hamilton-Jacobi's equation and the action-angle
variables
- to explain the principles behind the time-dependent and time-independent perturbation
theories and show how to apply them to simple mechanical systems.
- to formulate the separability conditions and to solve the Hamilton-Jacobi equation for separable systems
- to find all the adiabatic invariants of a given mechanical system
- to apply the time-dependent perturbation theory technique to problems with a Hamiltonian
slightly deviating from an exactly solvable one
- to relate symmetries of a mechanical system with the existence of dynamical invariants
- to generalise the Lagrange formulation of discrete mechanical systems to continuous
systems

Teaching and assessment
Teaching consists of lectures and problem solving sessions. Assessment is composed of
written assignments (take-home exams) and oral theory exam. To be admitted to the oral
exam the students should pass the written ones first. The final grade is determined

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| | by the<br>student performance at the oral exam.<br><br>Literature<br>The course is mainly based on the book by Goldstein, Poole and Safko, Classical Mechanics,<br>third edition, Addison Wesley, 2001 | | | | |