CLASSICAL MECHANICS

GENERAL OBJETIVES (4)

Main Objective: Review of the basic concepts and methods in classical mechanics to familiarize the students with an advanced level.

TOPICS AND SUBTOPIC (5)

	Topics	theory (hours)	Practice (hours)	Weeks
1	**Newtonians mechanics** • Newton´s laws. • Conservation theorems. • Work and energy. • Applications.	20	10	5
2	**Oscillatory motion (Linear oscillators)** • The simple harmonic oscillator. • Damped harmonic motion. • Forced oscillations.	12	6	3
3	**Lagrange and Hamilton mechanics** • Euler´s equation. • Euler´s equation: Constraint. • Hamilton´s principle. • Generalized coordinates. • Lagrange´s equations. • Conservation theorems. • The canonical equations of motion.	24	12	6
		56	28	14

BIBLIOGRAFY

1. J. B. Marion, Classical Dynamics of Particles and Systems (4th ed. New York: AcademicPress, 1995)
2. Hauser, W. Introduction to the Principles of Mechanics. 1a ed. Mass, Addison, Wesley, 1965.

LEARNING ACTIVITIES (6)

1. Exposition of concepts.

2. Problems resolution.

GRADING CRITERIA (7)

1. Participations and problems resolution in class.
2. Homework.
3. Exam evaluations.

Ultima modificación:

Dr. Julio Villanueva Cab

ELECTROMAGNETISM

GENERAL OBJETIVES (4)

To allow students (a) master the basic concepts in Electromagnetism, (b) get the skills in solving problems with the simplest geometries, and (c) understand the foundations of the physical laws involved. The purpose is to train the student for the advanced course in Electrodynamics offered during the first year of graduate school.

TOPICS AND SUBTOPICS (5)

	Topics and Subtopics	Class (Hrs.)	Problem Solving (Hrs.)	Weeks (No.)
1	**Electrostatics** • Coulomb's Law • Conservative Fields and Their Properties • Electrostatic Potential Field • Gauss's Law and Applications • Electric Fields Produced by Simple Geometries • Multipole Expansion • Potential Energy of a Group of Point Charges • Electrostatic Potential Energy of a Charge Distribution • Energy Density of a Electrostatic Field • Dielectrics	16	8	4
2	**Laplace's Equation** • Poisson's and Laplace's Equations • Uniqueness Theorem • Solution in Spherical Coordinates • Conducting Sphere in a Uniform Electric Field • Solution in Cylindrical Coordinates • Solution in Rectangular Coordinates • Method of Images	12	6	3
3	**Magnetic Field** • Electric Current • Magnetic Force • Biot-Savart Law • Magnetic Flux • Ampère's Law • Magnetic Fields Produced by Simple Geometries	16	8	4

	• Magnetic Vector Potential • Magnetic Scalar Potential • Magnetic Dipole • Magnetization • Magnetic Energy			
4	**Maxwell’s Equations** • Faraday’s Law of Induction • Self-Inductance • Mutual Inductance • Neumann Formula • Generalized Ampère’s Law • Maxwell Equations • Wave Equation • Power and Poynting Vector	12	6	3

BIBLIOGRAPHY

1. John R. Reitz, Frederick J. Milford, Robert W. Christy, Foundations of Electromagnetic Theory. Addison Wesley, 4th. Edition (May 19, 2008).
2. Matthew N.O. Sadiku, Elements of Electromagnetics. Oxford University Press, 6th Edition (January 16, 2014).
3. David J. Griffiths, Introduction to Electrodynamics. Addison Wesley, 4th Edition (October 6, 2012).
4. Gerald Pollack, Daniel Stump, Electromagnetism. Addison-Wesley, 1st. Edition (October 28, 2001).
5. Daniel Fleisch, A Student's Guide to Maxwell's Equations. Cambridge University Press, 1st. Edition (January 28, 2008).

LEARNING ACTIVITIES (6)

- Exposition and discussion on physical concepts.
- Solution and discussion of problems.
- Sessions on problem solving.

GRADING CRITERIA (7)

- Initial exam for diagnostics.
- Midterm exams for each topic.
- Homework.
- Final exam.

MODERN PHYSICS

	TOPIC	Theory (number of hours)	Exercise Session (number of hours)	Number of Weeks
1	**Relativity** Special Relativity Time Dilation Doppler Effect Length Contraction Twin Paradox Lorentz Transformation Relativistic Momentum Mass and Energy Energy and Momentum Electricity and Magnetism (*) General Relativity (*)	4 10	2 5	1 2.5
2	**Particle Properties of Waves** Electromagnetic Waves Blackbody Radiation Photoelectric Effect X-Ray Production X-Ray Diffraction Compton Effect Pair Production (*) Photons and Gravity (*)	4 6	2 3	1 1.5
3	**Wave Properties of Particles** De Broglie Waves Describing a Wave Phase and Group Velocities Particle Diffraction Particle in a Box Uncertainty Principle	4 6	2 3	1 1.5
4	**Atomic Structure** The Nuclear Atom Electron Orbits Atomic Spectra The Bohr Atom Energy Levels and Spectra Correspondence Principle Nuclear Motion (*) Atomic Excitation The Laser	8	4	2

5	**Quantum Mechanics** Time Dependent Schröd. Equation Linearity and Superposition Expectation Values Operators Time Independent Schröd. Equation Finite Potential Well Tunnel Effect Harmonic Oscillator	8 6	4 4	2 1.5
6	**Quantum Theory of the Hydrogen Atom** Schröd. Eq. for the H Atom Variable Separation Quantum Numbers Electron Probability Density Radiative Transitions (*) Selection Rules (*) Zeeman Effect (*)	8 4	4 2	2 1
7	**Many-Electron Atoms** Electron Spin Sym. and Antisym. Wave Functions Periodic Table Atomic Structure Explaning the Periodic Table Spin-Orbit Coupling (*) Total Angular Momentum (*) X-Ray Spectra (*)	8 6	4 3	2 1.5
8	**Molecules** The Molecular Bond Electron Sharing The H_2^+ Molecular Ion The Hydrogen Molecule Complex Molecules (*) Rotational Energy Levels (*) Vibrational Energy Levels (*) Electronic Spectra of Molecules (*)	8 4	4 2	2 1
9	**Statistical Mechanics** Statistical Distributions Maxwell-Boltzmann Statistics Molecular Energies in an Ideal Gas Quantum Statistics Rayleigh-Jeans Formula Planck Radiation Law Specific Heats in Solids Free Electrons in a Metal (*) Electron-Energy Distribution (*)	8 6	4 3	2 1.5
		56	**28**	**14**

BIBLIOGRAPHY

1. A. Beiser, ***Concepts of Modern Physics*** (McGraw-Hill, 6th edition, 2003).

2.	R. Eisberg& R. Resnick, ***Quantum Physics of atoms, molecules, solids, nuclei and particles*** (2th ed. Editorial Wiley 1985).
3.	R. A. Serway, ***Modern Physics*** *Cengage Learning* (3rd edition, 2012)

(*) Discussion of concepts at a qualitative level without going into details of the formal theory.

(†) The proposed number of hours (in pairs) devoted to theory and exercise sessions, can either of them be chosen as the teacher imparting the subject judges more convenient in his/her view. Although the number of hours dedicated to each subject is flexible, it's important to stress that all topics must be covered in a 14-week period.

<u>Teaching Method:</u>

The course is to be imparted in the traditional form of seminars where concepts and mathematical formulas are explained by writing on the board, and/or assisted, if desired, by power point presentations containing material of various sources (texts, articles, catalogues, etc.) As an essential complement of the course, exercise sessions must be given, aimed at engaging the enrolled students to solve problems (selected by the teacher) for all topics covered throughout the course. These sessions can be coordinated by the teacher him/herself, or else, by designated PhD students –*<u>closely supervised by the teacher</u>*– who follow a Physics Program at our institute.

<u>Evaluation Method:</u>

The enrolled students ought to pass a series of partial exams –and optionally deliver also some homework assignments that may have a weight in the final grade achieved in the course– with a minimum average final grade of 8 (in our grading system, the top mark is 10).

Mathematical Methods

Dr. Carlos Pando
Dr. Alfonso Rosado

AIMS: (4)

-Review and proper strengthening of the knowledge imparted in the courses of mathematics at the Bachelor's degree in physics

-The student should be prepared for using the mathematical tools needed in the Master Degree courses (Classical Mechanics, Electrodynamics, Quantum Mechanics and Statistical Physics).

TOPICS (5)

	TOPIC	Theory (number of hours)	Exercise Session (number of hours)	Number of weeks
1	Vector Analysis. Vector Integration; Parametric Curves; Surfaces. Green's Theorem, Stokes' Theorem, Gauss' Theorem, in domains simply and multiply connected	8	4	2
2	Lineal Algebra. Matrices; Lineal System Equations, Solution Methods; Matrix Diagonalization; Elemental Group Theory; Applications in Physics.	12	6	3
3	Infinite Series. Definition of Convergence, Convergence Tests; Algebra of Series; Taylor's Expansion One-dimensional and Multi-dimensional; Fourier Series.	4	2	1
4	Ordinary and Partial Differential Equations. Basic Theorems; First-order Ordinary Differential Equations; N-order Ordinary Differential Equations, Solution Methods. Equations of Parabolic Type: Heat Diffusion Equation, Solution Methods. Equations of Hyperbolic Type: Waves Propagation Equation, Solution Methods.	12	6	3
5	Complex Variable. Algebra of the Complex Numbers; Cauchy-Riemann Equations; Laplace Equation; Cauchy's Theorem.	12	6	3
6	Special Functions: Gamma Function; Legendre Functions; Hermite Functions; Laguerre Functions.	8	4	2
	84 Hours	56	28	14

Bibliography

G. Arfken, Mathematical Methods for Physicists (6th ed. Elservier, 2005).
R. V. Churchill & J. W. Brown, Complex Variable and Applications (9th Edition, McGraw-Hill, 2014).

LEARNING ACTIVITIES (6)

- Exposition and discussion on physical concepts.
- Solution and discussion of problems.
- Sessions on problem solving.

GRADING CRITERIA (7)

- Initial exam for diagnostics.
- Midterm exams for each topic.
- Homework.
- Final exam.