COURSE INFORMATION					
Course Title	*Code*	*Semester*	*L+P Hour*	*Credits*	*ECTS*
MODERN THEORETICAL PHYSICS	PHYS 654	4	4 + 0	4	10

Prerequisites	-

Language of Instruction	English
Course Level	Graduate
Course Type	Compulsory
Course Coordinator	Prof. Dr. Avadis Hacinliyan
Instructors	Prof. Dr. Avadis Hacinliyan
Assistants	
Goals	Special and General Relativity, Continuous Media, Fluids, potential Theory, Relation between classical and quantum mechanics, Thermodynamics and Statistical Mechanics, Introduction to classical and quantum chaos theory. Emphasizes the mathematical foundations and computational techniques used in these theories.
Content	Potential Theory. Mechanics of continuous media and fluids. Review of special relativity, tensor analysis and introductory general relativity. Einstein equations. Schwarzschild solution. Post Newton approximation. The Eikonal equation, geometrical and physical optics. Relation between classical and quantum mechanics. Classical Thermodynamics and constitutive relations. Micro canonical, canonical and grand canonical distributions. Quantum statistics. Special topics in statistical mechanics. (Bose-Einstein condensation. Fermi energy. Debye theory and Ising model). Simple systems with chaotic behavior. Small denominators and classical perturbation theory. Fractals. Stability and Bifurcation Theory.

Learning Outcomes	**Teaching Methods**	**Assessment Methods**
1) Introduce the physical nasis of classical and quantum mechanics.	1,2,3	A,B,C
2) Lay the mathematical and mechanical foundation for problems that the student will encounter in graduate studies, particularly in mechanics.	1,2,3	A,B,C
3) Skill to apply knowledge in physics and mathematics.	1,2,3	A,B

4) Teach the basic principles of thermodynamics and statistical physics.	1,2,3	A,B
5) Introduce exact and approximate computation methods	1,2,3	A,B,C
6) Introduce nonlinear systems and chaos theory.	1,2,3	A,B,C
7) Understand classical theories of continuous media and their physical and technological applications.	1,2,3	A,B,C

Teaching Methods:	1: Lecture, 2: Problem Sets, 3: Presentations
Assessment Methods:	A: Examination, B: Homework C: Presentation

COURSE CONTENT		
Week	**Topics**	**Study Materials**
1	Physics and Geometry. Classical physics in Minkowsky Space. Tensor analysis.	Modern Physics, Math Methods.
2	Canonical transformations and the Hamilton Jacobi Equation. Correspondance Principle. Hamilton Jacobi and Schroedinger Equations.	Math. Meth. İn Physics
3	Review of electromagnetic Theory. Energy Momentum four vector. Gauge invariance in Maxwell's Equations. Yang Mills Theory. integrals, Noether’s theorem.	Electromagnetic Theory and quantum mechanics.
4	Geometrical and Physical Optics, The eikonal equation in electromagnetic theory and geometrical optics, the corresponding relation between Hamilton Jacobi Equation and Quantum Theory.	Electromagnetic Theory and quantum mechanics
5	General Relativity, Einstein Equation and Schwarzschild solution.	Math. Meth. Phys.
6	Comparison of Newtonian Mechanics and Einstein Theory. Post Newtonian approximation.	Math. Meth. Phys
7	Midterm Examination	
8	Kinetic Theory, Statistical Mechanics and Distributions.	Statistical Mechanics.
9	Quantum Statistics and its applications.	Modern Physics. Statistical Mechanics.
10	Classical mechanics of continuous media. Elasticity.	Math. Meth. Phys
11	Introductory Fluid Mechanics	Math. Meth. Phys
12	Measures of Entropy Information and Chaos. Fractals and Lyapunov Exponents.	Mechanics
13	Hamiltonian Chaos, The Toda and Henon Heiles Problem.	Math. Meth. Phys

14	Classical and Quantum Perturbation Theory	Moder Physics
15	General Revision and Midterm Exam	

RECOMMENDED SOURCES	
Textbook	R.P. Feynman Quantum Electrodynamics W A Benjamin 1961; Applications of Classical Physics by Roger D. Blandford, Kip S. Thorne Publisher: California Institute of Technology 2008 Hermann Haken "Synergetics" Springer (2004) K. Huang Statistical Mechanics 2nd Edition Wiley (1987)
Additional Resources	Introduction to the Theory of Relativity by a foreword by A. Einstein by Peter Gabriel Bergmann Prentice Hall 1942, L.D.Landau and E. M. Liftshitz The Classical Theory of Fields Pergamon Press (1971).

1	Skill in appliying knowledge of Physics and Mathematics.					**X**
2	Experiment (measurement, research setup etc.) design and execution, ability to analyze and interpret experimental results.			**X**		
3	Provide a level of instruction that would satisfy the sciantific and technological measurement requirements of the industry.	**X**				
4	Ability to work in interdisciplinary teams.		**X**			
5	Ability to define, formulate and solve physical problems.					**X**
6	Awareness of professional and ethic responsability.			**X**		
7	Effective communication skills.			**X**		
8	Providing the necessary instruction for industrial application of physics and contributions of physics to society.		**X**			
9	Skill to develop awareness about the necessity of life long learning and achieving this.				**X**	
10	Knowledge and awareness of current professional subjects and technological developments.			**X**		
11	Skill to use techniques and modern apparatus in Physics applications.				**X**	

x

MATERIAL SHARING	
Documents	Georg Joos "Theoretical Physics"
Assignments	From Textbook
Exams	

ASSESSMENT

IN-TERM STUDIES	NUMBER	PERCENTAGE
Mid-terms	2	80
Quizzes	4	10
Assignment	8	10
Total		**100**
CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE		40
CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE		60
Total		**100**

COURSE CATEGORY	Expertise/Field Courses

COURSE'S CONTRIBUTION TO PROGRAM						
No	Program Learning Outcomes	Contribution				
		1	2	3	4	5
1	Gets a sound base for the main fields of physics such as Classical Mechanics, Quantum Mechanics and Electromagnetism,					X
2	Gets the ability of interpreting, analysing, forming a synthesis and relationships between the main fields of physics and/or other sciences,					X
3	Obtains the education required for the measurements in scientific and technological areas and the contribution of physics in the industrial applications and on the macroscopic scale such as the society,				X	
4	Follows the up-to-date scientific developments, makes the analysis/synthesis for the new ideas and evaluates them,				X	
5	Uses the academic sources, the computer technology and the related devices,		X			
6	Joins the working and research groups, also the scientific meetings, communicates well at the national and international level,		X			
7	Gets the ability of creative and critical thinking, problem solving, researching, producing a new and original work, improving himself/herself in his/her own fields of interest,					X
8	Gains the concepts of ethics and responsibility. Undertakes the responsibility for the solutions to the problems related with his/her field as required for having an intellectual identity.		X			

ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION			
Activities	Quantity	Duration (Hour)	Total Workload (Hour)

Course Duration (Including the exam week: 16x Total course hours)	16	4	64
Hours for off-the-classroom study (Pre-study, practice)	16	5	80
Mid-terms	2	10	20
Quizzes	4	1	4
Homework	8	3	24
Problem Hour and Presentation (Preparation included)	5	8	40
Final examination (Reparation Exam included)	2	10	20
Total Work Load			252
Total Work Load / 25 (h)			10
ECTS Credit of the Course			10