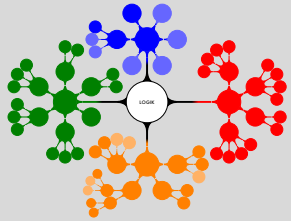
Lecture 1

First Meeting

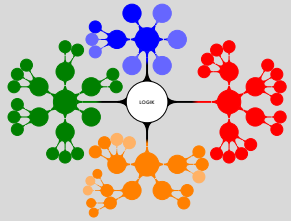
Lecture Information

Mse228 *Engineering Quantum Mechanics* at February 14, 2017

Dr. Cem Özdoğan
Engineering Sciences Department
İzmir Kâtip Çelebi University



Contents

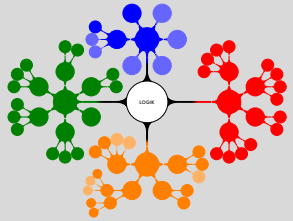


First Meeting & Introduction

- MSE228 Engineering Quantum Mechanics Spring 2017
- WEDNESDAY 09:30-12:15 (T1) Ortak Alanlar - B1-01
- Instructor: Cem Özdoğan, Engineering Sciences Dept. Faculty of Engineering and Architecture Building, Z-43
- TA: NA
- WEB page: http://boron.physics.metu.edu.tr/ozdogan/
- Announcements: Watch this space for the latest updates.

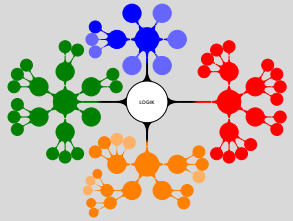
  ```
  January 26, 2017 In the first lecture, there
  will be first meeting. The lecture notes will be
  published soon, see Course Schedule section.
  ```

- All the lecture notes will be accessible via Tentative Course Schedule & Lecture Notes.



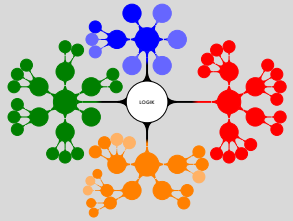
Lecture Information

- You may be expected to do significant homework assignments and problem solving.
- An understanding of the concepts of elementary calculus, differential equations and Newtonian mechanics is required.
- You should review calculus and in particular solutions of differential equations.
- The necessary differential equations and Newtonian/wave mechanics are explained as needed.
- Important announcements will be posted to the Announcements section of the web page above, so please check this page frequently.
- You are responsible for all such announcements, as well as announcements made in lecture.



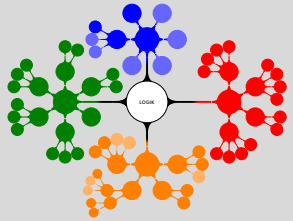
Course Overview I

- MSE228 is intended to provide students with a comprehensive introduction to the standard concepts in modern physics.
- This course is an introduction to quantum mechanics.
- Topics include
  - particle nature of light and wave nature of matter,
  - introductory quantum theory of atoms and introductory quantum mechanics,
  - special theory of relativity.



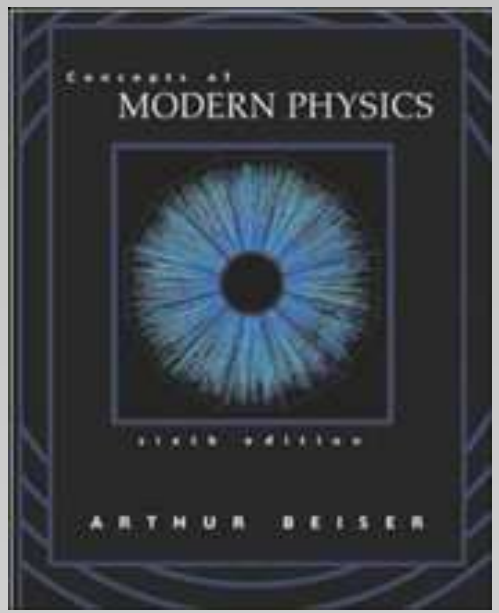
Course Overview II

- Upon completion of this course the students will be able to understand/explain/apply;
  - Failure of Newtonian mechanics.
  - Transition from classical to quantum physics.
  - Why relativity and quantum mechanics and are need to explain natural phenomena.
  - Blackbody radiation, photoelectric effect, wave-particle duality of matter and light.
  - Bohr/Rutherford theory of the atom
  - Schrödinger's equation, wave functions.
  - Heisenberg uncertainty principle.
  - Solutions to Schrödinger's equation in one dimension.
  - Introduction to fundamental structure of matter.
  - From electronic structure of atoms to solid state physics

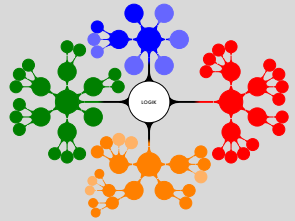


Text Book I

- Lecture material will be based on them. It is strongly advised that student should read textbooks rather than only content with the lecture material supplied from the lecturer.
- Required: Concepts of Modern Physics by Arthur Beiser, 6th edition, 2003, McGraw-Hill.

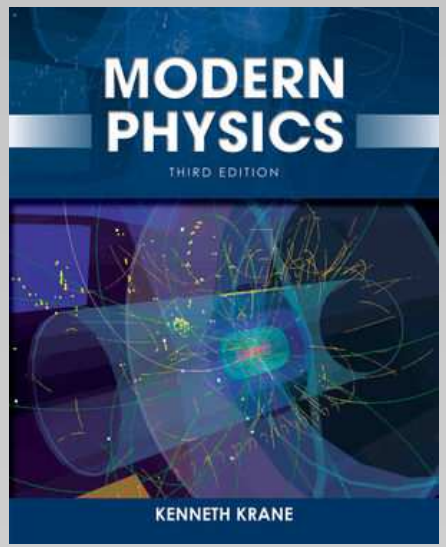


Required

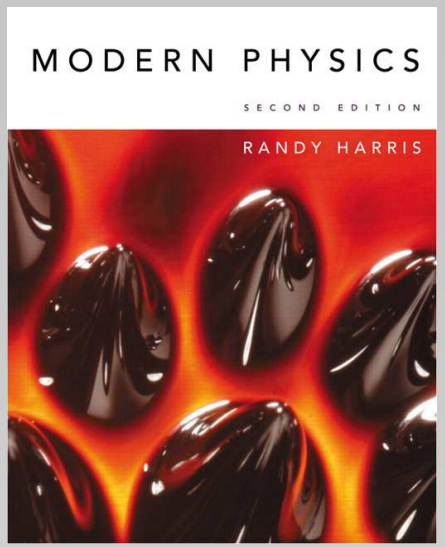


Text Book II

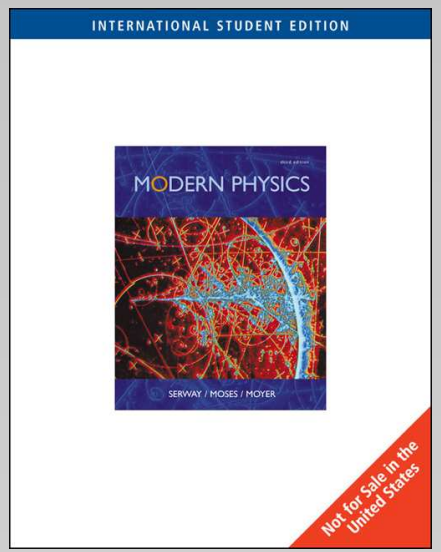
- Recommended: Modern Physics by Kenneth Krane, 3rd edition, 2012, Wiley.
- Recommended: Modern Physics by Randy Harris, 2nd edition, 2008, Pearson.
- Recommended: Modern Physics by Raymond A. Serway, Clement J. Moses, Curt A. Moyer, 3rd edition, 2005, Cengage Learning.



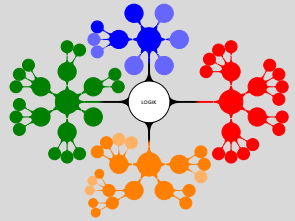
Recommended



Recommended

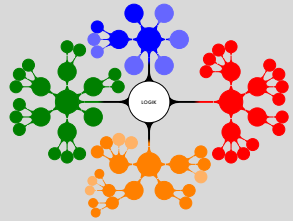


Recommended



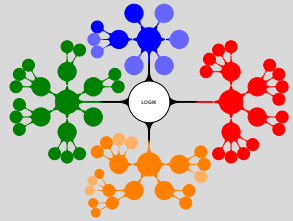
Grading Criteria

- Midterms & Final Exams: There will be two midterms and one final exam, will count 20% each and 40% of your grade, respectively.
- Homeworks/Assignments (or Term Project): 10%.
- Quiz: %10
- Attendance is required for the students' success and constitutes part of your course grade as bonus; 5%



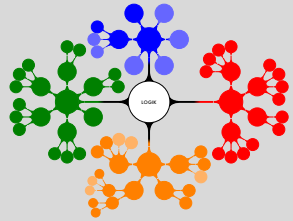
Policies I

- Attendance is not compulsory (30%), but you are responsible for everything said in class.
- Academic Regulations:
  Derslere devam zorunluluğu ve denetlenmesi
  MADDE 18 - (1) Öğrencilerin derslere, uygulamalara, sınavlara ve diğer çalışmalara devamı zorunludur. Teorik derslerin % 30'undan, uygulamaların % 20'sinden fazlasına devam etmeyen ve uygulamalarda başarılı olamayan öğrenci, o dersin yarıyıl/yılsonu ya da varsa bütünleme sınavına alınmaz. Tekrarlanan derslerde önceki dönemde devam şartı yerine getirilmiş ise derslerde devam şartı aranıp aranmayacağı ilgili birim tarafından hazırlanarak Senato onayına sunulan usul ve esaslar ile belirlenir.



Policies II

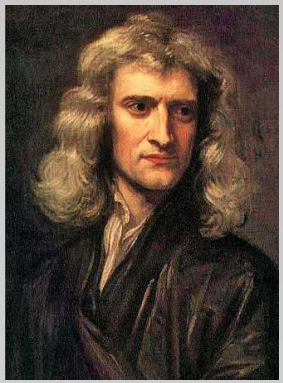
- The quiz will be open-book and open-notes and conducted after the completion of each chapter.
- Late homework will be accepted with a penalty of 10% per week after due date.
  - You are allowed to work in groups of two students on the homework unless otherwise mentioned.
  - You can use ideas from the literature (with proper citation).
  - You can use anything from the textbook/notes.
- At the end of the semester, your lowest homework, quiz score will be dropped.
- Exams: 1 page of notes (double sides) is allowed.
- I encourage you to ask questions in class. You are supposed to ask questions. Don't guess, ask a question!



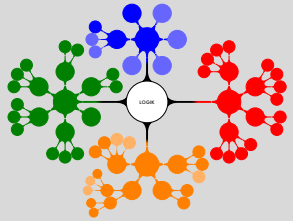
Physics around 1900

- Classical Physics : physics before 1900
  - Thermodynamics,
  - Electromagnetism,
  - Classical mechanics
- Newtonian Physics -> generality, simplicity, precisely fit experimental observations
- Newtonian mechnaics and Maxwell's laws of electromagnetism work very well to describe macroscopic objects
- Kepler's laws: accurate for many objects

- Developed in the 1800's
- Force and acceleration are related to each other through inertial mass
- Mass was recognized as a body's tendency to resist changes in motion (inertia)
- All things could be predicted

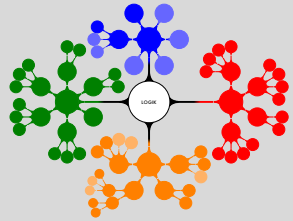


Isaac Newton 1642-1726



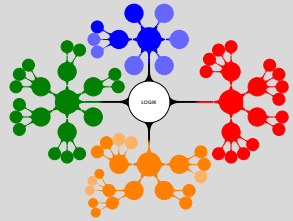
Newtonian Physics

- Electromagnetism. Electricity and magnetism were revealed as two faces of the same underlying phenomenon
- All electric and magnetic phenomenon could be described as waves
- Light identified as a wave phenomenon
- Space and time are the same for all observers, regardless of their state of motion
- Energy is different from mass and both came in continuous units
- Light was identified as alternating electric and magnetic waves traveling at $c = 2.995 \times 10^8$ m/s.
- It was assumed that light (as all EM waves) propagated in medium (the ether) and was affected by the motion of that substance.



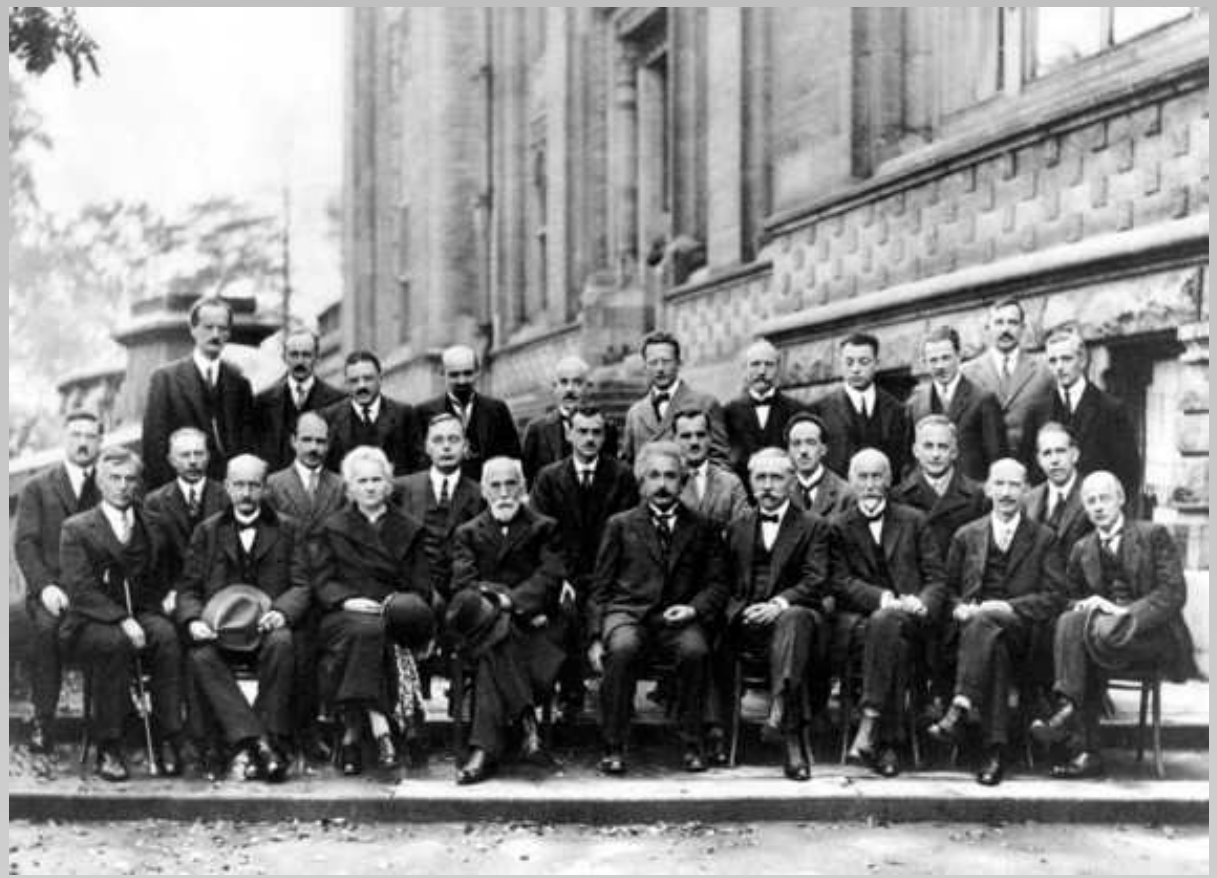
Failures of Newtonian physics I

- Failure of classical physics gives rise to modern physics
- Everything deviating from Newtonian mechanics has been considered as modern physics
- Michelson and Morley Experiment (1887)
  - Light was unaffected by the motion of the observer
  - Speed of light does not depend on the direction of the light
- The properties of glowing hot bodies could not be explained. Heat theory failed to explain the energy emitted by a blackbody
  - Heat is the thermal motion of atoms in a body. Consider heat trapped in a cavity (blackbody).
  - The emitted spectrum of energy becomes infinite as the energy of radiation increases!
  - However, measured spectrum of real blackbodies show an increase and then cut-off



Failures of Newtonian physics II

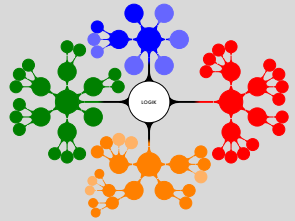
- The atomic structure of matter was not know and several experiments proved the existence of atoms
- Einstein's Brownian motion experiment and his explanation of the photoelectric effect (1905)



5th Solvay Conference on Electrons and Photons

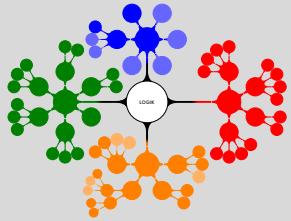
5th Solvay Conference on Electrons and Photon

17 Nobel prize winners in the photo

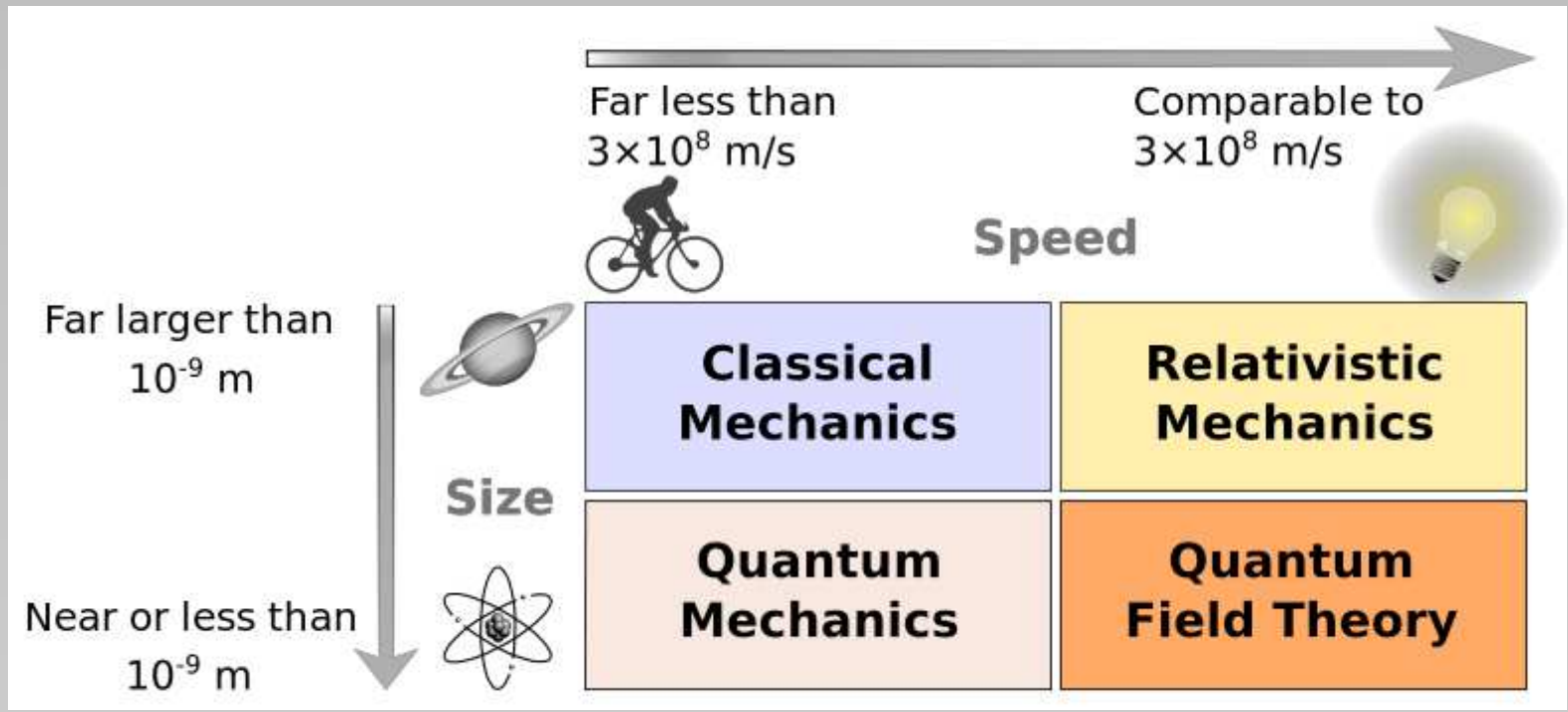


Modern Physics

- Modern Physics : Physics after 1900
- Two Basic Ideas:
  1. Time and space are not absolutes
  2. Particles behave like waves and waves behave like particles
- We can then explore areas of modern physics by understanding of Special Relativity and Quantum Mechanics
  - Particle nature of light and wave nature of matter
  - Atomic and nuclear structure
  - Quantum physics
  - Introductory quantum theory of atoms
  - Special (General) theory of relativity
  - Theory of relativity



Size vs Speed



Size vs Speed Table

Dr. Cem Özdoğan