SYLLABUS for Spring 2020 CORE-UA 209 Physical Science: Quarks to Cosmos

Class meeting time: T,Th 2:00 PM – 3:15 PM 12 Waverley Place Room L120

Prof. Allen Mincer 726 Broadway Room 850 212-998-7707 allen.mincer@nyu.edu
Office hours: T 11:30am-12:30pm, F 9:30am – 10:30am.

Course assistants: Alex Cushen, Christina Liu

Laboratory: Room 161 Meyer Hall (4 Washington Place)

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<tr>
<th>Section</th>
<th>Instructor</th>
<th>Email</th>
<th>Office Hours / Location</th>
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<tr>
<td>2 M</td>
<td>Isaac Sarnoff</td>
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<td>TBD / 726 B’way Rm 801</td>
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<td>3 M</td>
<td>Isaac Sarnoff</td>
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<td>5 M</td>
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COURSE DESCRIPTION:

Modern science has provided us with some understanding of age-old fundamental questions, while at the same time opening up many new areas of investigation. How old is the Universe? How did galaxies form? What are the fundamental constituents of matter and how do they combine to form the contents of the Universe? The course will cover measurements and chains of scientific reasoning that have allowed us to reconstruct the Big Bang by measuring little wisps of light reaching the Earth, to learn about sub-atomic particles by use of many-mile long machines, and to combine the two to understand the Universe as a whole from the sub-atomic particles of which it is composed.

COURSE COMPONENTS:

As explained in the following, this is a “flipped” course. It includes pre-recorded lessons, in class activities, homework, and laboratory. On the Classes site for this course, which can be accessed from NYU Home, there is a Course Overview tab on the left-side margin. The “About This Course” and “Getting Started” sections there explain a bit about the course and also provide details on how to enter your answers for Learning Checks, in-class activities, and homework.

The full set of lectures for the class have been pre-recorded by the professor and are available on the Classes site. Your are required to view these before coming to class. There are several lectures per class session, and each lecture is followed by one or more graded Learning Checks. You may watch any segment as many times as you wish before attempting the required Learning Checks. If you get a Learning Check wrong, review the material and try again. Only your last response will be graded. The deadline for completing each set of lectures and Learning Checks is 11:55pm on the evening before the class covering that material. The specific dates are posted on the site.

Class meetings will consist of working on collaborative small-group problems and activities. These activities are designed to review and complement the lessons by exploring the implications of the subjects discussed. Class attendance is required: responses to activities are to be submitted during class and will be graded. The course professor and assistants oversee the in-class activities and answer questions, but the goal of the activities is for classmates to help each other think through the ideas that are being studied.
Homework assignments are accessible on the NYU Classes website. These are designed to reinforce the lessons and to provide practice in applying the ideas to problems. HW due dates are displayed on the Classes site. HW assignments are usually due 7:55am on the Monday morning following the week in which the material is covered. The two exceptions are the weeks followed by exams: Week 5 HW will be due 7:55am Thurs. March 5th and Week 10 HW will be due 7:55am Thurs. April 9th

You must be registered for a laboratory section as well as lecture. The labs are designed to provide some feel for and appreciation of how one actually performs the sorts of measurements described in the lessons, and how one arrives at conclusions based on measurements. At the beginning of each lab there will be a short quiz to determine whether you have read the laboratory manual section for the experiment before coming to class. Reports for each lab are to be submitted in a manner and according to a schedule that will be described by your laboratory instructor. Unexcused absence from 3 or more labs will result in a zero for the lab component of the grade.

For an absence to be excused you need to provide proper documentation (eg. doctor’s note for an illness). If you know ahead of time that you must miss a class or lab for a valid reason (eg., religious observance or school-related trip) please inform your instructor ahead of time.

There will be two exams during the semester and a final exam. Much of the material in the course cannot just be memorized but requires pondering; learning checks, in-class activities, homework and laboratory provide good preparation in this regard.

TEXTBOOKS:
- There is no required textbook for the lecture part of this course.
- There is a required Laboratory Manual

DISCUSSION FORUM:

There is a Forums section on the Classes site. This provides a space for you, the students, to ask each other questions about the lessons and HW. You are encouraged to ask about material that is unclear in the lessons and to answer questions others have.

COURSE GRADING:
- Learning Checks 10%
- 2 Midterms 15% each
- Final 15%
- HW 15%
- Laboratory 20%
- In-class activities 10%
SCHEDULE

WEEK 1
Jan. 28: Class 1 – Introduction, Physical laws and theories, distance scales, unit conversions
Jan. 30: Class 2 – Experimental error and uncertainty, hypothesis testing
Jan. 27: – No lab this week

WEEK 2
Feb. 4: Class 3 – Geometrical methods, parallax
Feb. 6: Class 4 – Orbital motion, Kepler’s laws, size of the solar system
Feb. 3: Lab – Measurement and Uncertainty

WEEK 3
Feb. 11: Class 5 – Properties of motion, causes of motion, position, displacement, velocity, and acceleration.
Feb. 13: Class 6 – Forces, Newton’s Laws
Feb. 10: Lab – Parallax

WEEK 4
Feb. 18: Class 7 – Gravitation
Feb. 20: Class 8 – Energy
Feb. 17: No lab this week – Presidents’ Day

WEEK 5
Feb. 25: Class 9 – Electric forces
Feb. 27: Class 10 – Magnetic Forces, Thomson experiment, electrons
Feb. 24: Lab – Kinematics

WEEK 6
Mar. 3: Class E1 – Exam 1 on material of Weeks 1 through 4.
Mar. 5: Class 11 – Atoms, electrolysis, Millikan experiment, mass and charge of electrons and atoms
Mar. 2: Lab – Review for Exam I

WEEK 7
Mar. 10: Class 12 – Waves
Mar. 12: Class 13 – Radioactivity, nature of the atom, Rutherford experiment
Mar. 9: Lab – Measuring the Size of a Molecule

WEEK 8
Mar. 17 Spring recess
Mar. 19 Spring recess
Mar. 16: Spring recess, no Lab.
Mar. 2: Class 1 – Photoelectric Effect, wave/particle properties of light, quantum physics

Mar. 6: Class 1 – Light emission and absorption, atomic energy levels, blackbody radiation

Mar. 23: Lab – Measuring Avogadro’s Number

Mar. 31: Class 16 – Doppler Effect

Apr. 2: Class 17 – Distances to stars and galaxies, inverse square, standard candles

Mar. 30: Lab – Interference and Diffraction of Light

Apr. 7: Class E2 – Exam 2 on material of Weeks 5 through 9

Apr. 9: Class 18 – Olbers’ paradox, Hubble’s law, Big Bang

Apr. 6: Lab – Review for Exam 2

Apr. 14: Class 19 – Special relativity 1

Apr. 16: Class 20 – Special relativity 2

Apr. 13: Lab – Photoelectric Effect

Apr. 21: Class 21 – General relativity

Apr. 23: Class 22 – Isotopes, nuclear stability, neutron, anti-particles, conservation laws

Apr. 20: Lab – Measuring Doppler Effect

Apr. 28: Class 23 – Spin and parity, strong and weak nuclear forces, muons, pions, neutrinos, baryons, leptons, and exchange particles

Apr. 30: Class 24 – Strange particles and more particles and properties, quarks, the Standard Model, experimental particle physics, discovery of the Higgs.

Apr. 27: Lab – Inverse Square Law: Measuring Light Intensity

May 5: Class 25 – Dark Matter, Cosmology 1

May 7: Class 26 - Last class meeting, Cosmology 2

May 4: Lab – Principle of Equivalence

May 11: Lab – Review for final

The Final Exam is on Thursday May 14th at 2:00pm – 3:50pm, in the same room as class meetings, 12 Waverley Place Room L120