SYLLABUS for Spring 2018 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: by appointment

Course assistants: Joseph Corrado & Kaitlyn Morrell

Laboratory: Room 161 Meyer Hall (4 Washington Place)

<table>
<thead>
<tr>
<th>Section</th>
<th>Instructor</th>
<th>Email</th>
<th>Office Hours / Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 W</td>
<td>Ian Harnarine</td>
<td><a href="mailto:iankh@nyu.edu">iankh@nyu.edu</a></td>
<td>TBA</td>
</tr>
<tr>
<td>3 W</td>
<td>Kaizhe Wang</td>
<td><a href="mailto:kw2223@nyu.edu">kw2223@nyu.edu</a></td>
<td>TBA</td>
</tr>
<tr>
<td>4 Th</td>
<td>Kaizhe Wang</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Th</td>
<td>Ian Harnarine</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 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. However, once you attempt a Learning Check your first response will be used in calculating the grade for that item. The deadline for watching each set of lectures and completing their Learning Checks is posted on the site. It is 11:55pm on the evening before the class covering each lesson’s material.

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 typically due 7:55am on the Monday morning following the week the week in which the material is covered. The one exception is the week in which there is a Tuesday exam (on Feb. 27th) for which the HW will be due Thursday morning (March 1st).

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. If you know ahead of time that you will need to miss a lab, speak with your instructor to see if you can make up the lab in another session that week.

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% for attempting the questions and 8% for correct solutions)
- 2 Midterms 15% each
- Final 15%
- HW 15%
- Laboratory 15%
- In-class activities 15%
SCHEDULE

WEEK 1

Jan. 23: Class 1 – Introduction, Physical laws and theories, distance scales, unit conversions

Jan 25: Class 2 – Experimental error and uncertainty, hypothesis testing

Jan. 24 and 25 – No lab this week

WEEK 2

Jan 30: Class 3 – Geometrical methods, parallax

Feb 1: Class 4 – Orbital motion, Kepler’s laws, size of the solar system

Jan. 31 and Feb. 1: Lab – Measurement and uncertainty

WEEK 3

Feb. 6: Class 5 – Properties of motion, causes of motion, position, displacement, velocity, and acceleration.

Feb. 8: Class 6 – Forces, Newton’s Laws

Feb. 7 and 8: Lab – Parallax

WEEK 4

Feb. 13: Class 7 – Gravitation

Feb. 15: Class 8 – Energy

Feb 14 and 15: Lab – Kinematics

WEEK 5

Feb. 20: Class 9 – Electric forces

Feb. 22: Class 10 – Magnetic Forces, Thomson experiment, electrons

Feb. 21 and 22: Lab – Review for Exam I

WEEK 6

Feb. 27: Class 11 – Exam 1 on material of Weeks 1 through 4.

Mar. 1: Class 12 – Atoms, electrolysis, Millikan experiment, mass and charge of electrons and atoms

Feb. 28 and Mar. 1: Lab – Measuring the size of a molecule

WEEK 7

Mar. 6: Class 13 – Waves

Mar. 8: Class 14 – Radioactivity, nature of the atom, Rutherford experiment

Mar. 7 and 8: Lab – Electrolysis

WEEK 8

Mar. 13 Spring recess
Mar. 15 Spring recess
Mar. 14 and 15: Spring recess, no Lab.
Mar. 20: Class 15 – Photoelectric Effect, wave/particle properties of light, quantum physics

Mar. 22: Class 16 – Light emission and absorption, atomic energy levels, blackbody Radiation

Mar. 21 and 22: Lab – Young’s experiment

Mar. 27: Class 17 – Doppler Effect and Cosmological Red Shift

Mar. 29: Class 18 – Distances to stars and galaxies, inverse square, standard candles

Mar. 28 and 29: Lab – Review for Exam 2

Apr. 3: Class 19 – Olber’s paradox, Hubble’s law, Big Bang

Apr. 5: Class 20 – Exam 2 on material of Weeks 5 through 9

Apr. 4 and 5: Lab – Photoelectric effect

Apr. 10: Class 21 – Special relativity 1

Apr. 12: Class 22 – Special relativity 2

April 11 and 12: Lab – Measuring Doppler effect

Apr. 17: Class 23 – General relativity

Apr. 19: Class 24 – Isotopes, nuclear stability, neutron, anti-particles, conservation laws

April 18 and 19: Lab – Measuring light intensity

Apr. 24: Class 25 – Spin and parity, strong and weak nuclear forces, muons, pions, neutrinos, baryons, leptons, and exchange particles

Apr. 26: Class 26 – Strange particles and more particles and properties, quarks, the Standard Model, experimental particle physics, discovery of the Higgs.

April 25 and 26: Lab – Principle of Equivalence

May 1: Class 27 – Dark Matter, Cosmology 1

May 3: Class 28 - Last class meeting, Cosmology 2

May 2 and 3: Lab – Review for final

The Final Exam is on Tuesday May 15 at 2:00pm – 3:50pm, in the same room as class meetings, 12 Waverley Place Room L120