昆山杜克大学
DUKE KUNSHAN UNIVERSITY

PHYSICS 131SK

Frontiers of 21st Century Physics

Spring 2015, Session 1

Academic Credit: 1 course
Areas of Knowledge: NS
Modes of Inquiry: STS
Course format: lecture, lecture + discussion, field trips (can accommodate up to 25 students)

Instructor's Information

Haiyan Gao, Chair, Department of Physics (co-taught with colleagues)

Prerequisite(s), if applicable

Precalculus and at least one quantitative science course at high school level

Course Description

Introduction to six big questions representing frontiers of 21st century physics, such as what are the ultimate laws of nature, how does complex structure arise, and how can physics benefit society. Classes will involve presentations by researchers and by students, discussions of journal articles, and tours of physics labs involved with related research. Prequisites: Precalculus and at least one quantitative science course at the high school level, such as chemistry or physics. Can accommodate up to 25 students.

Course Goals / Objectives

Students will be expected to master the materials at several different levels of the Revised Bloom Taxonomy, from defining and describing information (lower level) to assessing, evaluating, creating, and integrating information (higher level). Assignments will be aligned with course objectives in a logical manner. Because most of the assignments are written essays and class presentations, students will be expected to display skills in the logical development of an argument, proper

literature citations, and other aspects of scientific writing. Rubrics for evaluation will be provided for all assignments so that students will understand the expectations for each task.

Required Text(s)/Resources

Students will use articles from the primary research literature, popular science magazines, as well as review articles and other bibliographic sources.

Recommended Text(s)/Resources

There are no required textbooks. All reading materials will be provided by the instructor(s) and/or available online.

Additional Materials (optional)

PowerPoint

Course Requirements / Key Evidences

Class participation (15% of grade)

1 introductory essay (individual work) (15% of grade)

2 midterm essays (individual work) (20% of grade each)

Group presentation (3-4 people, PowerPoint presentation ~30 minutes each (20 minutes for presentation, 10 minutes for Q&A) based on one of the Big Questions listed below (30% of grade):

BQ1: What are the ultimate laws of nature?

BQ2: What are the uses of quantum mechanics?

BQ3: How do strongly coupled systems work?

BQ4: How does organized behavior arise in complex systems?

BQ5: What does physics say about biological phenomena?

BQ6: How can physics benefit society?

Technology Considerations, if applicable

The Duke Sakai system will be used. The lectures and discussions will be conducted mostly through PPT presentations and online resources.

Assessment Information / Grading Procedures

Rubrics for written essays will be provided ahead of time and students will be given their evaluation sheets from scored rubrics. ESL students will receive advice and counseling on their English skills if required or will be referred to the English Writing courses offered at DKU by the Thompson Writing Program faculty. A rubric for the PowerPoint group presentation will also be created.

Diversity and Intercultural Learning (see Principles of DKU Liberal Arts Education)

The instructor has extensive experience in the university systems and cultures of both China and the US. She has hosted delegations of visiting Chinese scholars, both Chinese high school and university students, and Chinese exchange students in the Physics Department at Duke University. She will also recruit colleagues from Chinese universities for co-teaching and guest lectures. All aspects of the classroom experience, from field trips to group presentations to library work, will be accomplished with attention to intercultural sensitivity and awareness of global cultural diversity.

Course Policies and Guidelines

- The group (3-4 students) needs to work on the presentation together and submit ppt slides to the instructor before the class presentations. Each group may select one person to make the presentation to the entire class or choose to divide the time among group members. All members need to participate in the Q&A session.
- While group discussion and collaboration are highly encouraged, students are expected to follow The Duke Community Standard. Details about the Duke Community Standard can be found at http://studentaffairs.duke.edu/conduct/about-us/duke-community-standard.
- Students are required to attend all classes. Absence will be excused for special circumstance such as illness, family emergency upon written request in advance.
- All required work needs to be submitted on or before the published due day. In special cases such as illness and family emergency, extension may be granted following written request.
- Cell phone use is not allowed during classes, laptop use in class is allowed only for searching for information relevant to the class discussion with the permission of the instructor.

Tentative Course Outline or Schedule

Syllabus

The class meets 3 times a week and each time 100 minutes.

Week 1: What are the ultimate laws of nature?

Lecture 1: Introduction on fundamental forces and Standard Model

Lecture 2: Introduction of symmetries and symmetry breakings

Lecture 3: Dark matter, dark Energy and other unknowns

Week 2: What are the uses of quantum mechanics?

Lecture 1: Introduction to Quantum Mechanics

Lecture 2: Quantum Cryptography

Lecture 3: Quantum computer and quantum communication

Weak 3: How do strongly coupled systems work?

Lecturer 1: Introduction to Quantum Chromodynamics

Lecturer 2: Structure of the Nucleon

Lecture 3: Strongly correlated electronic systems

Week 4: How does organized behavior arise in complex systems?

Lecture 1: Introduction to complex systems

Lecture 2: Granular materials

Lecture 3: Non-linear dynamics of charged particle beams

Week 5: What does physics say about biological phenomena?

Lecture 1: Introduction to Biophysics

Lecture 2: Single molecule biophysics with a twist

Lecturer 3: Molecular Biophysics

Week 6: How can physics benefit society?

Lecture 1: Medical imaging

Lecture 2: Energy

Lecture 3: Internet, web and large data set

Week 7: Class presentations

Post / course codes pending
18 February 2014