Spring 2016

Science, Technology, and Society 345

**Physics in the Modern World: Copenhagen to Manhattan**

Tu-Th 2:00-3:20 (29 class sessions) in Harned 143

Andy Rex Office Hours:

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Course homepage: <http://www.pugetsound.edu/faculty-pages/rex/sts345/>

**Course Materials Available in the Puget Sound Bookstore:**

* Richard Rhodes: *The Making of the Atomic Bomb* (1986)
* David Cassidy: *Einstein and Our World* (2nd ed. 2004)
* Richard Overy: *Why the Allies Won* (1996)
* Doris Bergen: *War and Genocide: A Concise History of the Holocaust* (2009)
* Course package containing selected reprints and technical information

**Note:** Additional materials are provided as needed on Moodle.

**Bulletin Description:**

This course examines the mutual interactions between physics and other forms of culture in the modern world, centering on the development of relativity and quantum theory. These great ideas of modern physics are analyzed critically in light of the effects they have produced in the world at large, with particular attention to the building of the atomic bomb. A number of scientific, cultural, political, and philosophical themes leading up to the conception and building of the atomic bomb will be considered.

**Multiple University Requirements Satisfied by STS 345:**

Connections courses must create connections between disciplines with respect to methodology and content. This course satisfies the Connections requirement by being designed to contribute to students’ understanding of the interrelationship of knowledge between science and the humanities. Similarly, STS courses make useful connections between scientific work and studies of the history or philosophy of science. By making strong historical connections, this course is applicable to the STS major or minor. Finally, this course can be applied to the university’s requirement for 300-level courses outside the major. Although there are no formal prerequisites, expectations for reading, analysis, and writing level are commensurate with a 300-level experience.

**Course Outline:**

The primary focus of the course is the blossoming of knowledge that occurred in the physical sciences (particularly physics) in the period 1895-1945, studied within the context of the larger world in that period. That context is manifested primarily in two categories. First, there is the intellectual world that includes literature, the arts, and culture associated with the modernist period. Second, there is the political world that saw the rise of Communism and Fascism and included two world wars. In keeping with the Connections core rubric, developments in science, culture, and the political world will be considered in relation to one another frequently throughout the course.

**Attendance policy:**

We expect you to be present every day and participate actively. (See notes below on participation grade.) Attendance will be recorded. We excuse absences for legitimate reasons, provided you notify us by e-mail no later than the day of your absence. Some examples of legitimate reasons include illness, family emergencies, graduate school interviews, and university-sponsored activities such as performing arts and athletics. With only 29 class sessions on the Tuesday-Thursday schedule, you should make every effort to attend class. More than one unexcused absence may result in your automatic withdrawal from the course.

**Assignments:**

Written assignments for the course will include frequent short reaction papers based on the reading assignments, one class-based essay and one research paper, a midterm exam and a final examination.

* Active participation in the course is expected of all students. With each student participating actively, students’ diverse skills and interests enrich the experience for all. In order to participate, students must be present and alert; a pattern of absences will indicate a decided failure to meet the requirements of the course. Perhaps students engage the course in the most obvious way when they contribute constructively to discussion, whether through an insightful comment, a telling observation, or a pertinent question. Yet students may demonstrate a positive involvement with the course in many other ways as well—through consultation with the professor when that is needed or helpful, or through supportive intellectual relationships with other students. The largest single measure of participation will be in short written responses (reaction papers) to questions about the readings, given with the day’s reading assignment and due at the beginning of the next class period. The quality (not simply quantity) of a student’s participation in the course will account for **30% of the final course grade**.
* A midterm exam will be given on Thursday, March 10. The format for the exam will be discussed ahead of time, but it will cover mostly scientific material presented in the first half of the course. The midterm exam will account for **15% of the final course grade**.
* A significant essay of 4-5 pages will be due a week or two after the midterm break. Students will be given one or more writing prompts and will be expected to base the essay on class readings done to that point in the course. The essay will account for **15% of the final course grade**.
* A research paper will be due in class at the end of the fourteenth week (April 28). Students will be asked to augment class materials by identifying and making use of sources external to the course. Each student will submit a one-page précis and bibliography for the paper in the week prior to the due date. The paper will be approximately eight to ten pages in length and will account for **20% of the final course grade**. (A more detailed assignment will be given just after the first shorter essay is complete.)
* The final examination will be held in the time slot provided in the course schedule (see the Registrar’s electronic schedule) and will not be offered at any other time. The final examination will provide **20% of the final course grade**.

**Phase One:**

**Energy Conservation Principles and Atoms; European History through World War I**

January 19—February 11 (8 sessions)

 Rhodes: *Making of the Atomic Bomb*

 1 Moonshine

 2 Atoms and the Void

 3 *Tvi*

 4 The Long Grave Already Dug

 5 Men from Mars

 6 Machines

 7 Exodus

 Cassidy: *Einstein and our World*

 1 The Einstein Age

 2 Début de Siècle

 3 Technical Expert, Third Class

 Bergen: *War and Genocide*

 1 Preconditions

 2 Leadership and Will

Rex/Thornton: *Modern Physics for Scientists and Engineers*, 4th ed., Chapter 15 (General Relativity), selections in course packet

 Penderecki: *Threnody for the Victims of Hiroshima* (1960)

 Adams: *Doctor Atomic* (2005)

We begin our study with some background in classical physics, focusing on the concept of energy. In the early twentieth century, some classical ideas were replaced by relativity and quantum theory, which are not only the foundations for most of twentieth century physics, but also provide the critical underpinnings for the Manhattan Project. In relativity we will follow the development of the theory due to Einstein. We will then turn to quantum theory, from the discovery of the electron to Bohr’s early atomic theory to the full wave/matrix theory of Schrödinger/Heisenberg. The Bohr/Einstein debates will be discussed as we ponder the nature of indeterminacy in quantum mechanics. Some crucial experimental work belongs to this period, such as the discovery of x rays, radioactivity, and the electron. In history we will study the events and conflicts leading up to and through World War I and consider the war’s aftermath. Our study includes understanding the role that scientists played in that war, an important prelude to their larger role in World War II.

**Phase Two:**

**Development of Nuclear Physics; Political History and the Beginning of World War II**

February 16—March 10 (8 sessions)

 Cassidy: 4 Impact on Physics: Relativity

 5 Impact on Physics: The Quantum

 6 Relativity Reaches the Public

 7 Cultural Resonances

 Rhodes: 8 Stirring and Digging

 9 An Extensive Burst

 10 Neutrons

 11 Cross Sections

 Overy: *Why the Allies Won*

 Preface

 1 Explaining World War II

 2 The Battle for the Seas

 Bergen: 3 From Revolution to Routine: Nazi Germany 1933-1938

 4 Open Aggression: In Search of War 1938-1939

Rex/Thornton: *Modern Physics for Scientists and Engineers*, 4th ed., Chapter 12 (The Atomic Nucleus), selections in course packet

Our scientific study now turns to the discovery of the neutron and the subsequent discovery of nuclear fission. International events including the rise of Nazism and Communism and the implementation of anti-Semitism will be considered. We will see the early beginnings of the intrusion of governments into massive, industrialized, politically motivated scientific research, which will be integrated into the analysis of the evolution of physics. World War II begins in Asia and Europe, with devastating impacts on the citizens who live there, including scientists.

**Phase Three:**

**The Manhattan Project, 1942-1945; World War II on Many Fronts**

March 22—April 21 (10 sessions)

 Rhodes:12 A Communication from Britain

 13 The New World

 14 Physics and Desert Country

 15 Different Animals

 16 Revelations

 17 The Evils of This Time

 Overy: 3 Stalingrad and Kursk

 4 Bombers and Bombing

 5 The Invasion of France

 7 Technology and Military Power

 8 Allies and Leaders in War

 Bergen: 6 Expansion and Systematization

 7 The Peak Years of Killing (pages 167-82 only)

 8 Death Throes and Killing Frenzies, 1944-45 (pages 215-226 only)

 BBC Video Documentary: History of World War 2 (selected scenes)

During this phase we will use Rhodes’s *The Making of the Atomic* Bomb as our main text for understanding the development of nuclear weapons. Our study of the 1930s will feed into discussion of World War II and the decision to assemble an international team of scientists at Los Alamos to develop an atomic bomb. We will study the scientific and technical problems that had to be overcome in order to produce an atomic bomb by the end of World War II. This phase of the course will permit us to examine intellectual controversies, personal conflicts, political disagreements, and governmental involvement in science. This is an exciting subject because so much documentary and dramatic material exists for us to use. It will be easy to gain a sharp sense of the personalities involved in the struggle to get the atomic bomb before the Nazis. We will continue the discussion of scientists’ roles in public policy through the efforts and opinions of major players, including Szilard, Einstein, Lawrence, Teller, and Oppenheimer. For historical analysis concerning the course of the conventional fighting in World War II, we will rely on Overy and Bergen. The conventional war rages on several fronts as the scientists, motivated largely by the course of the war, finally succeed in producing nuclear weapons.

# Phase Four:

**Hiroshima and Nagasaki—Immediate Aftermath and Long-term Effects**

April 26—May 3 (3 sessions)

 Rhodes: 18 Trinity

 19 Tongues of Fire

 Epilogue

 Overy: 9 The Moral Contest

 10 Why the Allies Won/Epilogue

 Isaacs/Olivier: 24. The Bomb (From ITV series *World at War*) (1973 video)

 Malone: *Knowledge or Certainty* (1974 video)

Is the result of all this modern physics a net gain for society and culture, or a net loss? In this phase we will examine this question. Because we are following in the footsteps of an extensive study of the atomic bomb, students will have some foundation to begin to answer this question. If time permits, we can also begin to look at the Cold War, as one specific outcome of World War II and the development of the atomic bomb.

**Syllabus inserts**:

1. If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Peggy Perno, Director of the Office of Accessibility and Accommodations, 105 Howarth, 253.879.3395. She will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

2. Classroom Emergency Response Guidance

Please review university emergency preparedness and response procedures posted at [www.pugetsound.edu/emergency/](http://www.pugetsound.edu/emergency/). There is a link on the university home page. Familiarize yourself with hall exit doors and the designated gathering area for your class and laboratory buildings.

If building evacuation becomes necessary (e.g. earthquake), meet your instructor at the des­ignated gathering area so she/he can account for your presence. Then wait for further in­structions. Do not return to the building or classroom until advised by a university emergency response representative.

If confronted by an act of violence, be prepared to make quick decisions to protect your safety. Flee the area by running away from the source of danger if you can safely do so. If this is not possible, shelter in place by securing classroom or lab doors and windows, closing blinds, and turning off room lights. Lie on the floor out of sight and away from windows and doors. Place cell phones or pagers on vibrate so that you can receive messages quietly. Wait for further instructions.