History and Science of the Manhattan Project — Syllabus

Spring 2023, Deep Springs College, Prof. **Brian Hill**

Overview

The Manhattan project is a chance to look simultaneously at the almost unbelievable scientific and technological developments which came in rapid succession just before, during, and after WWII, and at their historic consequences. The fundamental science begins in the late 1800s with the discovery of natural radioactivity (by Becquerel and the Curies), the development of controlled fission (Fermi's atomic pile), and the possibility of violent fission chain reactions. The history includes the race to make weapons based on fission, the destruction of two cities, and the setting of the stage for the superpower stalemate that has continued with slowly shifting characteristics decade-after-decade ever since.

A study of the Manhattan Project is not just an opportunity to study momentous scientific developments and past events. Its ongoing significance makes it nearly a duty to understand what we have collectively created. By the end of the course, each person will have their own response to the events and the resulting situation.

Unit Outline

Term 4 — Fundamental Physics and Atomic Technology

I. The Atom, and Basic Physics for Nuclear Fission

II. Discovery of Radioactivity

III. Physics Background needed for Chapter 2 of Reed on Controlled Fission (Enrico Fermi's Atomic Pile)

IV. Possibility of a Fission Bomb (A-Bomb)

V. The Race to Develop the Atomic Bomb

VI. Assembly of the Manhattan Project Scientists

VII. Creation and Refinement of Fissile Isotopes

Term 5 — Weapons Design and the Arms Race

VIII. Gun and Implosion Designs for Criticality

IX. Technology to Deliver a Bomb

X. The First Three Atomic Bombs: Trinity, Little Boy, and Fat Man

XI. The Destruction of Hiroshima and Nagasaki

XII. The Fusion Bomb (H-Bomb)

XIII. The Arms Race and The Beginning of the Cold War

XIV. Mutually Assured Destruction and Arms Control

Primary Text (2nd Edition, 2019, Required)

- *The History and Science of the Manhattan Project, 2nd Edition*, 2019 by Bruce Cameron Reed on **Amazon** or **AbeBooks** (the 1st Edition is much different and not suitable for this class)

Other Resources

- Robert Serber: *The Los Alamos Primer* — The physics of the atomic bomb as it was presented to scientists as they arrived in Los Alamos in the early 1940s — Advanced (something I look at occasionally)
- "Eyewitness Accounts of the Bombings of Hiroshima and Nagasaki," by Meilan Solly
- By popular request, *Oppenheimer,* Universal Pictures, but not expected until July, 2023! Maybe The Watchmen or Dr. Strangelove instead?

Grading

- A one-hour exam covering the science toward the end of each term, worth 20% of the grade (x2 for the two terms). Homework problems on the science, 40%. A paper 1500-1800 words on a topic of your choice at the end of the second term, 10%. Consistent preparation for and participation in class discussion, 10%.
- Regarding the two exams: since we will cover a very wide variety of scientific topics, and as a result, it may not be clear what you might be expected to do on an exam, practice exams will be provided. Problems on the actual exam will cover the same topics at approximately the same difficulty level. However, the actual problems will require you to come at some of the concepts from new directions.
- Regarding the paper: share a draft for peer-editing (post-outlining method). Final draft to be circulated to peers and professor. Read all of the each others' papers as the final reading and discussion.

Miscellaneous Policies

There will be a lot of handouts. Get a three-ring binder to keep all the handouts and problem sets organized. Assignments should be on 8 1/2 x 11 paper (and not torn out from a bound notebook). Multi-page assignments should be stapled. Corrections should be erased (if done in pencil) or recopied (if done in pen). To make nice diagrams and graphs, you will often need a ruler.

The College's general policies on absences and late work are applicable. There was an email from the Dean on this September 8, 2022. The policies below are consistent with that email:

Whereas missed coursework affects both your classmates and professors by lowering the thinking and understanding you bring to a given class, and interrupts the course schedule that has been set up and is adjusted on an ongoing basis with substantial care. The same is true for absences — whereas a handful of absences might be “normal” at colleges with large lectures or less serious academics, at Deep Springs we expect students to miss *no classes* save for legitimate health issues or emergencies requiring also missing labor and governance obligations.

For a student wishing to submit a course assignment past its required deadline, the student may request an extension on the assignment directly from the professor 48 hours in advance. Within 48 hours of the due date, the student must request an extension directly from the Dean. Exceptions will be granted by the Dean only if the student faces unforeseen and unforeseeable circumstances. A student who misses the deadline will be penalized an amount that is roughly equivalent to a letter grade for each day the assignment is late. Assignments cannot be turned in after solutions and graded assignments have been passed back, which generally happens one to two classes after they were turned in.