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**HISTORY 108**

**SCIENCE AND TECHNOLOGY IN WORLD HISTORY**

**BULLETIN INFORMATION**

HIST 108 - Science and Technology in World History (3 credit hours)

**Course Description:**
The development of science and technology and their roles in world civilizations from antiquity to the present.

**SAMPLE COURSE OVERVIEW**

TBA

**ITEMIZED LEARNING OUTCOMES**

**Upon successful completion of History 108, students will be able to:**

1. Demonstrate knowledge of the principles of historical thinking to understand human societies, specifically through examining the history of the global development of science and technology from antiquity to the contemporary era.
2. Define and summarize major events, developments, and themes of the history of science and technology from antiquity to the contemporary era.
3. Evaluate significant themes, issues, or eras in the history of science and technology from antiquity to the contemporary era.
4. Demonstrate basic skills in the comprehension and analysis of selected sources and their relevance in the context of historical knowledge.
5. Demonstrate ability to recognize the differences between original historical source material (primary sources) and later scholarly interpretations of those sources (secondary sources).
6. Demonstrate ability to develop interpretive historical arguments drawing on primary and/or secondary sources.
7. Identify the sources and functions of values that guide human practices in science and technology.
8. Demonstrate an understanding of the importance of ethics, values and social responsibility in science and technology for individuals and for societies through the history of science and technology.
9. Demonstrate ability to reflect on how values shape personal and community ethics and decision-making in the context of science and technology.

**SAMPLE REQUIRED TEXTS/SUGGESTED READINGS/MATERIALS**

1. James E. McClellan and Harold Dorn, *Science and Technology in World History* (Baltimore: Johns Hopkins University Press, 2006)
2. Peter Dear, *The Intelligibility of Nature: How Science Makes Sense of the World* (Chicago: University of Chicago Press, 2006)
3. Sources posted to Blackboard (see schedule in Topical Outline of Course for specific information)

**SAMPLE ASSIGNMENTS AND/OR EXAMS**

This course will assess student achievement through the evaluation of class participation (including attendance, performance in directed class discussion, brief writing assignments, and/or quizzes), exams, and short essays based on historical sources. The exams will include short-answer section[s] and/or essay section[s] and will cover key terms, concepts, and interpretive themes and will require students to identify and analyze historical developments and social values held in the past by various communities and apply historical methods and ethical frameworks to interpret the past.  Written essays and weekly class discussions will encourage students to use diverse methods and skills to explore primary and secondary historical sources and apply historical methods and frameworks to interpret the past; they will also encourage students to analyze and reflect on how values and ethics have shaped personal and community ethics and decision-making.

1. Quizzes
2. 5 essays
3. 2 exams

**SAMPLE COURSE OUTLINE WITH TIMELINE OF TOPICS, READINGS/ASSIGNMENTS, EXAMS/PROJECTS**

**Week 1:** Introduction

**Class 1:** Introduction to the Course: Why does the history of science and technology matter?  What is and was science?  What are the values of science, how do they change, and what role do they play in the development of science?

The class will examine six defining issues for the historical study of science, technology and values, and for this course:

1. How the past matters to the present and what problems “presentism” plays for the study of the past.
2. How we find “history”: an introduction to historical methods and research, selecting and interpreting evidence and sources.
3. How historians of science and technology see the past less as a progression of breakthroughs triumphs and more as a constantly evolving, complex set of processes and forces that requires the ethical use of evidence.
4. How science, technology, and society have historically shaped one another; how the ethical and moral norms of past and present societies interact with developments in science and technology.
5. The way that values shape both the creation of scientific knowledge and the ways that knowledge informs societies’ self-understandings.
6. How we can analyze the moral actions of past scientists, engineers, physicians, and others according to both their values and norms and our own.

**Section I: Pre-Modern Science**

**Class 2:** Science and Technology in the Urban Revolution: Development of social hierarchies and division of labor.  The development of skilled labor, questions of forced labor and slavery.

Textbook reading: James McClellan and Harold Dorn, *Science and Technology in World History,* ch. 3;

Weekly Discussion Questions:  What is the value of controlling water and forming urban environments when such developments depend on slave and forced labor?

Key Vocabulary and Concepts*: Contingency, Chance, Power, Individualism, Community, Moral Values, Slavery, Division of Labor*

**Week 2**

**Class 3:** Greek Understandings of Nature: How Aristotle came to his views, taking into account earlier philosophers, including Plato and the pre-Socratics.   The dispute between Plato and Aristotle about how to access ideal forms and the true nature of things.  The Allegory of the Cave

**Class 4:** Rome as a Counterpoint to Greece: The rise of *techné* in service of the empire; competing notions of which knowledge is valuable; what it means for knowledge to have value.

Textbook Reading: chs. 4-5.

Discussion reading: Aristotle, Aristotle, *Physics* Book II (selection)

Weekly Discussion Questions: How would Aristotle reconcile his claims about determining the good versus all things having a natural order?  Why do these concepts look contradictory to us? Did Rome share this dilemma?

Key Vocabulary and Concepts*:  telos, metaphysics and physics, techné & episteme, empire*

**Week 3**

**Essay #1** (Reading an Artifact) due

                ESSAY PROMPT:

Select an artifact and treat it as a primary source to elicit its meaning from its structure. Your “reading,” set forth in a 750-word essay, should focus on the object itself.  What can this object tell you about the society that produced it? What systems of knowledge, values, technology, and transportation are necessary to produce (from raw materials) and use such an object? Is the object useful by itself? What does the object tell you about what the people who used it valued?  You may seek assistance from secondary sources for technical details, but information of a broader sort not rooted in the physical design of the artifact will be treated as irrelevant. We are interested not in what others have said about the object, but in what you can see in it -- if, say, you are examining a pencil, we do not want to see a history of pencils but rather your analysis of the specific pencil you're examining.

You may find it helpful to imagine that you're an archaeologist from some future civilization who has dug up an object produced by an early 21st century society. Remember that simple objects often tell very complex stories about the people who made and used them!

**Class 5:** Golden Age of Islamic Natural Philosophy: Community determination of how knowledge is stored, and who are the keepers of knowledge.  Creation and destruction of the House of Wisdom.  Science in the service of religion

**Class 6:** Medieval Natural Philosophy: Medieval social order, the value of stability, and views of the cosmos, Augustinian synthesis, Rediscovery of the classics.

Textbook Reading: ch. 6

Discussion Reading: Tertullian,Aquinas

Weekly Discussion Questions: Recalling earlier debates of Plato and Aristotle, how do their approaches inform the research agendas of medieval natural philosophers and shape their educational institutions?

Key Vocabulary and Concepts*: Humours, Scholastics, Astrolabe, House of Wisdom, Algebra*

**Week 4**

**Class 7:** Gothic Cathedrals and Medieval Engineering: Communities of Knowledge and their secrets; values societies possessed in order to build monumental structures.

**Class 8:** Why were you better off having a toothache in medieval China than in medieval Europe? Social stability and innovation in the societies; institutional autonomy versus centralized control; Knowledge and technology transfer (immutable mobiles?)

Textbook reading: ch. 7

Discussion Reading: David Macaulay, Shen Gua,

Weekly Discussion Questions: What are the similarities and differences among the Roman Empire, the medieval Catholic Church, and China’s Song dynasty in terms of their use of technologies and knowledge, social hierarchies, and the values that underpin these different societies?  How do they all manage to control so much territory and so many people?  How are societies’ values reflected in architecture and infrastructure?

Key Vocabulary and Concepts: *Bishopry and regional power, Masons, Scientific Bureaucracy, Know-how, Middle Kingdom, Chinese Traditional Medicine*

**Week 5**

**Section II: The Scientific Revolution in Europe**

**Class 9:** Instrumental versus Natural Philosophical Ways of Knowing: Following Peter Dear, we introduce the concepts of instrumentality and natural philosophy to show the dual aims of science: episteme/techné or knowing/doing.  Scientists aim to BOTH know (or construct) truth or to improve the human condition, but what element has greater weight changes from one culture and value system to another.  Dear argues that these two dimensions are related and a question of the perspective of the observer.

**Class 10:** Copernican Revolution: The discoveries of Copernicus, the departure from Ptolemaic models of the heavens (passed down from Rome through Islamic civilizations), and the major scientific and social consequences of this new models of the heavens.

Textbook Reading: ch. 10, 11 + Peter Dear

Discussion Reading: Copernicus, Sobel

Weekly Discussion Questions:  How did Copernicus decide to publish his theory?  What values led him to struggle with this decision and how did he ultimately decide?  What were the consequences of publishing?  How does the printing press, a technology, raise the stakes of scientific inquiry?

Key Vocabulary and Concepts: *Intelligibility, Instrumentality, Natural Philosophy, Heliocentrism, Geocentrism, Epicycles, publication*

**Week 6**

**Class 11:** Galileo’s Struggle and Triumphs: Galileo conformed his science to a changing cast of patrons—from the Arsenal of Venice, to the University of Padua, to the Medici at Florence.  Yet, in the end this savvy individual ended up in conflict with the most powerful patron in the Western World, the Catholic Church.

**Class 12:** Was the Scientific Revolution either scientific or revolutionary?  The scientific revolution introduced a new set of values as well as new approaches to knowledge.  This lecture takes Isaac Newton as an exemplar of the culture of the scientific revolution, and presents the Royal Society as an institution dedicated to advancing science but also bringing science to the public and politicians.

Textbook Reading: ch. 12; Dear, ch. 1

Discussion Reading: Newton, *Chymistry*

Weekly Discussion Questions: How do we reconcile Newton’s reputation as an icon of modern science with his activities as an alchemist and chronologist?  How does this conflict show the changing values both of and within science?

Key Vocabulary and Concepts*: Inquisition, Medici, Arsenal, Telescope, City State, Patronage, public criticism, Scientific Revolution, Royal Society, Chymistry, Alchemy*

**Week 7**

Essay #2 (The Church, Galileo, and the Problem of Censorship) due

READING FOR THE ESSAY: Galileo, Ernan McMullin, and John Heilbron, Ernan McMullin, editor.

ESSAY PROMPT:

Read Galileo’s Letter to the Grand Duchess Christina and two chapters from Ernan McMullin’s *The Church and Galileo*, “The Church’s Ban on Copernicanism” (McMullin) and “The Censorship of Astronomy after Galileo” (Heilbron).  The assignment is to consider the issue of censorship and the values that either support or oppose it.  Students must choose either to argue in favor of the Church’s censorship in the interest of maintaining authority and social stability or to support Galileo’s effort to publish against the Church’s wishes.  Essays should explore the complex arrangements of values and social norms that are either supported or threatened by the act of making new knowledge public and how communities make decisions about whether the potential social benefits of censorship override the benefits of expanding knowledge.  The essay also provides students an opportunity to reflect on their own values concerning censorship.

**Class 13**: Voyages of Discovery: Expeditions returned with natural goods that challenged conceptions of existing orders of flora and fauna.  Individual built reputations based on claims of novelty and wonders.  Amassing specimen collections became a way to establish status in science and the community.

**Class 14:** Enlightenment and the tension between the rational and empirical:  The Enlightenment is a changing moral framework for making sense of knowledge about the world.  The *Encyclopedie* is used an example of the Enlightenment project to democratize by elite experts.

Textbook Reading: ch. 13.

Discussion Reading: Mungo Park, Dear ch 2.

Weekly Discussion Questions: What motivates individuals to explore the world?  What motivated states to support the work of naturalists—why do it scientifically in terms of collecting and categorizing species?  How do scientific taxonomies evolve to handle the growth of information?

Key Vocabulary and Concepts: *Mechanics, Empiricism, Voyages of Discovery, Collecting, Linneaus*

**Week 8**

Midterm Exam

**Section III: Making Modern Science**

**Class 15:** Science and the State – Modern science develops hand-in-hand with the modern nation-state.  During the eighteenth century, the modern nation-state evolves into the pre-eminent patron of scientific activity.  Especially in France, state institutions control the training of scientists.  The state creates new mechanisms for recruiting and sorting people who will become scientific and engineering practitioners.  The state funds science that politicians see benefiting it and largely ignores science that will not apparently benefit the state’s accumulation of power.

**Class 16:** Quantification and the Rise of Statistical Thinking  -- Empirical science produces data, but what do scientists do with data?  What does the notion of ‘data’ even mean?  In the late eighteenth and early nineteenth century, mathematical methods of handling data, such as  statistics, emerge and create new kinds of scientific knowledge, often at the behest of the state and industries.

Reading: Ted Porter, Dear ch. 3

Weekly Discussion Questions: What demands do the state and industry put on science?  Is it appropriate to call these distortions of the scientific enterprise or is it false to think that science has some sort of “natural” path?  Do states with better scientific institutions have more power—why or why not?  How is quantification related to the rise of the nation-state; what do states use statistics for?

Key Vocabulary and Concepts: *Quantification, Statistics, Correlation, Causation, University*

**Week 9**

**Class 17:** A New Age of Technology: Utilitarianism and the Industrial Revolution in England, 1760-1820 Technology driven by scientific advances led to key innovations that transformed industries in England and beyond. Harnessing natural resources through new technology allowed for the replacement of human and animal labor with coal-fueled steam engines, water-driven mills, and other energy systems. The ramifications for labor, culture, and economics were profound.

**Class 18:** Darwin: Darwin began his career aboard the H.M.S. Beagle, observing and describing the diversity of life in locales around the world. Drawing inspiration from his voyages and from recent advances in the fields of geology and demography, Darwin articulated a theory of the evolution of species by natural selection. This theory of evolution, with its strong imagery of the struggle for existence, depicted a world in flux: where all species were changeable and every living thing battled constantly for its own survival.

Textbook Reading: ch. 14, 15

Discussion Reading: Dear ch. 3; Charles Darwin

Weekly Discussion Questions: Scientific categories shift with new discoveries and new discoverers: elements are found to be compounds, and species can change over time, and different kinds of people produce scientific knowledge. Given this reality, how can we create systems of classification that are stable, coherent, and fair?  Does the Malthusian concept of competition come into play in every system or society where individuals compete for limited resources? Can you have natural selection without believing that competition is intrinsic to nature?

Key Vocabulary and Concepts: *Steam Engine, Industrial Revolution, Malthus, Natural Selection, Evolution, Acquired Characteristics, Experimentation*

**Week 10**

**Class 19:** Cell Theory, Germ Theory, and the Emergence of Biology: A new scientific discipline, biology, forms around two emerging consensuses: 1) that complex living things are made up of cells; and 2) that some single-cell organisms are disease-causing agents.  Beyond bringing about a lasting shift in society’s conception and valuation of hygiene, the cellular understanding of life informed political and economic debates over the relationship between the needs of the individual and the needs of society.

**Class 20:** Galton, Genes, and Eugenics: Seeking a mechanism for Darwin’s theory of evolution, Francis Galton popularized the notion that an organism’s most important characteristics were innate rather than shaped by the environment or experience. He called the determinants of these characteristics “genes.” Coupled with Gregor Mendel’s studies of patterns of inheritance, Galton’s genes defined the modern nature-versus-nurture debate. Galton’s development of statistical methods to investigate genes serves as the starting point of an exploration of the relationship between quantitative measures, social values, and the question of using science to assess individuals, classes, and/or races.

Textbook Reading: ch. 16;

Discussion Reading: Dear ch 4; Stephen Jay Gould

Weekly Discussion Questions: How and why have scientists tried to measure people? What, exactly, was Galton trying to measure? What are some of the consequences of measuring people? Why did some societies try to guide human reproduction? Should societies do this?

Key Vocabulary and Concepts: *Cell, Germ Theory, Pathogen, Gene, Statistics, Scientific Racism, Social Darwinism*

**Week 11**

Essay #3 (Science, Empire, and Ranking People) due

READING FOR THE ESSAY: Charles Darwin, Francis Galton, Gilbert Malcolm Sproat

ESSAY PROMPT:

Examining Charles Darwin’s and Francis Galton’s descriptions of human races, address the following questions: 1) How did Darwin and Galton measure the worth of the races they discussed? 2) What are the connections between imperialism and the racial hierarchy Darwin and Galton proposed? 3) What values need to be in place to accept scientific racism of the sort found in Darwin’s and Galton’s writings? What values need to be in place to reject it?

**Class 21:** The Emergence of Physics The nineteenth century is the century in which scientific disciplines as we know them emerged.  Physics is taken to be an exemplary discipline.  The case of thermodynamics is used to should how physics formed as a discipline and the questions being a discipline raised for physicists in the late nineteenth century, especially considering the controversy over statistical mechanics and worries about whether stochastic processes were truly knowable.

**Class 22:** Professionalization of Science, Engineering, and Medicine  Along with the rise of disciplines as the key social institutions of science, science, engineering, and medicine also developed structures as professions, including structures for self-governance and maintaining the public’s trust, including codes of ethics, licensing agreements with the state, and exclusionary membership qualifications.

Textbook Reading: ch. 17;

Discussion Reading: Dear, ch. 5; Rowland

Weekly Discussion Questions: What are the consequences of disciplinization and professionalization?  Where does self-governance in science, medicine, and engineering fail or succeed and why?  Rowland’s “Plea for Pure Science” also served as a plea for improving higher education. What problems with higher education did Rowland identify, and what were his proposed solutions? How does higher education in America at the turn of the 20th century represent but also push certain social values (e.g., democratization, social mobility, etc.)?

Key Vocabulary and Concepts: *Thermodynamics, Energy, Professional Societies, Licensing, Codes of Ethics, Identity, malpractice*

**Week 12**

**Section IV: Science As We Know It**

ESSAY #4 (Bohr, Berg, and the Social Responsibility of the Scientist) due – see Assignments (above) for description of this essay.

READING FOR ESSAY: Niels Bohr, [Paul Berg](http://en.wikipedia.org/wiki/Paul_Berg), [David Baltimore](http://en.wikipedia.org/wiki/David_Baltimore), [Sydney Brenner](http://en.wikipedia.org/wiki/Sydney_Brenner), [Richard O. Roblin III](http://en.wikipedia.org/w/index.php?title=Richard_O._Roblin_III&action=edit&redlink=1), and [Maxine F. Singer](http://en.wikipedia.org/wiki/Maxine_F._Singer).

Essay Prompt:

Read physicist Niels Bohr’s 1950 speech to the United Nations and biologist Paul Berg’s statement about the Asilomar Conference on Recombinant DNA. Write a dialogue

**Class 23:** Light bulbs, Airplanes, and Automobiles: Using Thomas Edison, Henry Ford, and Orville and Wilbur Wright as examples, we explore the culture of innovation and invention at the turn of the 20th century in America.  Comparing Edison’s assembly line approach to his patent factory and Ford’s assembly line for car manufacture, this lecture explores the myth of the lone genius versus a workforce aligned to a single goal of production.  It also looks at the technical artifact as part of a larger system of infrastructure.

**Class 24:** A New Way of Understanding and Seeing the World: Quantum: Einstein reaches intellectual maturity during a confusing period in the 20th century, with experiments failing to show expected outcomes (Michelson-Morley) and the discovery of other unexpected natural phenomena (radioactivity).  As the framework for classical physics (indivisible and immutable atom) is undermined, a new research focus emerges for experimental and theoretical physics.

Textbook Reading: ch. 18,

Discussion reading: Dear, ch. 6; Henry Ford

Weekly Discussion Questions: Discuss the hierarchy of Ford’s $5/day wage and the values associated with each pay grade.  How does the Sociology Department extend Ford’s values from the factory into the home? Is there a relationship between Fordist ideology and Einstein’s epistemology?

Key Vocabulary and Concepts: *Einstein, Bohr, Quanta, Planck, electron, patent, assembly line*

**Week 13**

**Class 25:** Science and the State Part II: World War II Science and Technology: Chain Home (Radar) and The Manhattan Project (A-Bomb) are used to investigate how WW II altered scientific research and technological development, as well as how the war transformed the relationships between these two entities and the state.

**Class 26:** Medical Research in WWII: The process through which British and US researchers transformed penicillin from a laboratory accident into a mass-produced “wonder drug” exemplifies how the war brought a new mode of production—and new expectations—to medical research. Nazi German atrocities on human research subjects, and the international response to those atrocities, are explored to show how a society’s values define the ends and means of research.

Textbook Reading: ch. 19

Discussion Reading: Slater, Malaria Prevention booklet, Nuremberg Military Tribunal Proceedings

Weekly Discussion Questions: Discuss how the increasing involvement of the state in funding science affected the values of scientists. What questions did scientists raise about the independence and objectivity of state-directed science?  Despite its reliance on taxpayer funding, for most of its existence the Manhattan Project remained outside of the American public’s knowledge. What responsibility did scientists and engineers have in disseminating their work to the public? Using the Manhattan Project as a case study, weigh the benefits and drawbacks in inviting the public to decide what techno-scientific projects the government should support. Is it ethical to use data from Nazi doctors’ experiments?

Key Vocabulary and Concepts: *Radar, Operations Research, Manhattan Project, Atomic Bomb, Big Science, Military-Industrial Complex, Nuremberg Doctors’ Trial, Medical Ethics*

**Week 14**

Essay #5 (Watson, Crick, Franklin, and Wilkins: Who Discovered DNA?) due

READING FOR ESSAY: Watson and Crick, *Double Helix* (selections)*,* Elkin,“Rosalind Franklin and the Double Helix”

ESSAY PROMPT:

Who should get the most credit for elucidating the structure of DNA?  In your 750-word answer, consider the following questions: Who, in the case of the discovery of the double helix, is not given much recognition, and why?  Should we regard the possession of a Nobel Prize as a reasonably accurate measure of one’s value to science? What are the dangers of uncritically embracing Watson’s narrative? What are the dangers of outright dismissing, as several secondary sources do, that same narrative?  In collaborative projects (which are now the norm), how should credit be the project’s success/failure be distributed?

**Class 27:** Environmentalism and the Ecological World View The science of ecology arose out of Darwinian insight into the interconnectedness of plants, animals, and the physical environment. It created an understanding of nature based in describing complexity without simplifying it. Ecology’s view of the role of humans within the large-scale dynamics of the natural world came to inform and inspire environmentalism.

**Class 28:** Science and the State Part III, The Rise of Biomedical Research  Approaches to medicine were significantly impacted by the development of genetics and molecular biology. Experimental research into disease, genetics, and treatment came to parallel patient care as a priority of medicine. The role of private industry became increasingly important to the expansion and progress of biomedical research.

Textbook Reading: ch. 20;

Discussion Reading: Dear, Conclusion; Paul Ehrlich

Weekly Discussion Questions: Show how the research and theories of the science of ecology could be used to construct a political argument against environmental destruction (for example, a polluting factory, or an oil drilling project in sensitive areas).  Do scientists have a responsibility to do research that specifically benefits the public good? Who should pay for experimental biomedical research? If diseases are rare, should they be lower priority for funding?

Key Vocabulary and Concepts: ecology, complexity*, National Institutes of Health, cancer, research grant*

**FINAL EXAM: According to the University exam schedule.**