

Integrated Liberal Studies / History of Science 202
Western Culture: Science, Technology, Philosophy II
The Making of Modern Science

Spring 2009

3 Credits; N (Natural Sciences), ILS / H (Humanities), Hist. Sci.; E (Elementary).
2 hours lecture (1:20 pm MW, 5208 Social Sciences), 1 hour discussion.
Open to freshmen.

Instructor

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TAs

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Course Description: This course offers an introduction to the history of the sciences between the work of Isaac Newton in the late seventeenth century and Albert Einstein in the early twentieth, with the aim of understanding how science came to be so important in modern culture. Investigating the historical significance of such fundamental scientific concepts as gravity, energy, and evolution, and the complex interrelations between theory and experiment, we study the diverse ways that scientific and social values have been interwoven in Western culture. We explore the changing relations among science and technology, science and religion and science and the state, and cross both disciplinary and national boundaries to investigate the rise of the laboratory-based sciences, the changing cultural status of the scientist, and the professionalization of the scientific disciplines.

Note that this course conveys either **Natural Sciences** or **Humanities credit**, a difference that will be reflected in the discussion sections and examinations in ILS and History of Science respectively.

Book List (University Bookstore, A Room of One's Own...)

Peter J. Bowler and Iwan Rhys Morus, *Making Modern Science: A Historical Survey*
(Chicago: University of Chicago Press, 2005) Required

Betty Jo Teeter Dobbs and Margaret C. Jacob, *Newton and the Culture of Newtonianism*
(Amherst, NY: Humanity Books, 1995) Required

Course Reader Available for \$29 from History of Science Dept. Office, Social Sciences
7143 (cash or check only). Note that the office is open from 8-3 M-R and extended
hours in the first week of semester (8-4:30 M-R and 8-12 F), and that there are no
refunds on the reader. Required.

Note: All reading materials are also available on reserve at the College Library.

Assessment

Assessment is through three take-home essay exams written on selected topics (75% of the total grade), and section participation (25%). The section participation grade will test your comprehension of both lectures and readings, and some informal writing will be required for discussion sections.

First Take-Home Exam (20%): Distributed Feb. 18; due March 2.

Second Take-Home Exam (25%): Distributed April 1; due April 13.

Final Take-Home Exam (30%): Distributed April 29; due 12:05 P.M. Mon. May 11.

Honors Assessment

Honors students will work on a project on images and objectivity in the history of science, the details of which will be finalized early in the semester. It will be completed by May 6, and is worth 20% of the overall grade.

Participation and Performance

If you have a conflict between an academic requirement and any religious observance, please notify me of the specific dates concerned within the first two weeks of the course and I will find an alternative means for you to fulfill the requirement. Such requests are confidential.

In compliance with the Americans with Disabilities Act, I will make every effort to honor requests for reasonable accommodations made by individuals with disabilities. (If you think you qualify for accommodation, please contact the McBurney Disability Resource Center [263-2741; <http://jumpgate.acadsvcs.wisc.edu/~mcburney/>] to establish your eligibility for services.) Requests for accommodation can be responded to more effectively if I receive them as far in advance as possible, preferably at the beginning of the semester. Such requests are confidential.

If any problems arise, either academic or personal, that might jeopardize your performance in the course, you must try to inform me of the problem at the next available office hour, or by leaving a message with the Department of the History of Science (262-1406).

Syllabus

Items from the two books on our Book List are referred to by name (eg. **Bowler and Morus**, pp. 23-45). The other material is in the Course Reader. The readings listed are core material and ideally should be read before the relevant lecture.

Part 1: The New Sciences

Jan. 21 Introductions

Bowler and Morus, Chap. 1, "Science, Society and History" (optional), pp. 1-20.

Discussion Section: Introductions (discussing Science, Society, History and Time)

Jan. 26 Francis Bacon and the Reconstruction of Science

David S. Landes, "Clocks and the Wealth of Nations," *Daedalus* (Spring 2003): 20-26.

Bowler and Morus, pp. 23-25, 33-45.

Francis Bacon, *The New Organon* (1620), in *The New Organon and Related Writings* ed. Fulton H. Anderson (New York: Liberal Arts Press, 1960), pp. 33-49 and 93-103.

Jan. 28 René Descartes on Method and Matter

René Descartes, *Discourse on Method* (1637), as excerpted in Ralph M. Eaton, ed. *Descartes: Selections* (New Haven and London: Yale University Press, 1996), pp. 1-37.

Discussion Section: Framing the Scientific Revolution

Feb. 2 The New Societies

"The Introduction," *Philosophical Transactions* 1 (1665-1666): 1-2.

Robert Boyle, "A Letter of the Honorable Robert Boyle Concerning the Vegetable Nature of Amber Greece, according to an Extract Taken Out of a Dutch East Indian Journal," *Philosophical Transactions* 8 (1673): 6113-15.

Bowler and Morus, pp. 322-326 (and, for a thematic overview, 319-322).

Feb. 4 Isaac Newton and the New Natural Philosophy

Isaac Newton, "A New Theory About Light and Colours," (1672), and Queries 28 and 29 from *Optics* (4th ed., 1730) as excerpted in William Francis Magie, ed. *A Source Book in Physics* (Cambridge, MA: Harvard University Press, 1963), pp. 298-308.

Dobbs and Jacob, pp. 1-34.

Bowler and Morus, pp. 46-52.

Discussion Section: Newton's Prisms and the Royal Society – the "Crucial" Experiment

Feb. 9 Mechanics as a Model for Natural Philosophy

Margaret C. Jacob, "Thinking Unfashionable Thoughts, Asking Unfashionable Questions," *American Historical Review* 105 (2000): 494-500.

Dobbs and Jacob, pp. 34-60.

Isaac Newton, *Principia Mathematica Philosophiae Naturalis* (1687), as excerpted in Magie, *A Source Book*, pp. 30-46.

Part 2: From the Enlightenment Experiment to Industrial Revolution

Feb. 11 Newton, Newtonianism and the Age of Enlightenment

Dobbs and Jacob, pp. 61-110

Discussion Section: Newton's Mechanics and Enlightenment

Feb. 16 Benjamin Franklin and the Electrical Fluid

I. Bernard Cohen, *Benjamin Franklin's Science* (Cambridge, MA and London: Harvard University Press, 1990), "Benjamin Franklin's Scientific Style," pp. 14-30.

Letter 3 from Benjamin Franklin to Peter Collinson, Sept. 1, 1747, as reprinted in I. Bernard Cohen, ed. *Benjamin Franklin's Experiments: A New Edition of Franklin's Experiments and Observations on Electricity* (Cambridge, MA: Harvard University Press, 1941), pp. 179-186.

Feb. 18 The Chemical Revolution and the Enlightenment Balance

Antoine-Laurent Lavoisier, *Elements of Chemistry in a New Systematic Order, Containing All the Modern Discoveries* (1789), trans. Robert Kerr (New York: Dover, [1790] 1965), pp. xiii-xxxvii and 1-7.

Bowler and Morus, Chap. 3, "The Chemical Revolution," pp. 55-78.

Note: First Take-Home Exam Distributed

Discussion Section: Airs and Gases and the New Chemistry

Feb. 23 Electricity and Life

Mary Shelley, *Frankenstein, or, The Modern Prometheus* (New York: Doubleday, [1818] 1999), pp. 55-76.

Feb. 25 Linnaeus, Gender, and Natural History

Lisbet Koerner, "Carl Linnaeus in his Time and Place," in N. Jardine, J.A. Secord and E.C. Spary, eds. *Cultures of Natural History* (Cambridge: Cambridge University Press, 1996), pp. 145-162.

Bowler and Morus, Chap. 21, "Science and Gender," pp. 487-509.

Discussion Section: Science and Gender, Travel and the Environment

March 2 Humboldt, Scientific Travel, and Global Physics

Michael Dettelbach, "Humboldtian Science," in Jardine, et al., eds. *Cultures of Natural History*, pp. 287-304.

Note: First Take-Home Exam Due

March 4 Science and the Industrial Revolution: Watt's Steam Engine

Robert Friedel, *A Culture of Improvement* (Cambridge, MA: MIT Press, 2007), ch. 11, "Raising Fire," pp. 191-209.

Bowler and Morus, pp. 391-403.

Discussion Section: Science and the Industrial Revolution

March 9 The Rise of Energy Physics

Heinz Otto Stribum, "Reworking the Mechanical Value of Heat: Instruments of Precision and Gestures of Accuracy in Early Victorian England," *Studies in History and Philosophy of Science* 26 (1995), 73-106.

Bowler and Morus, pp. 79-95.

Part 3: The Age of Progress and the Rise of Evolution

March 11 Social and Biological Ideologies of Progress

Jean-Baptiste Lamarck, *Zoological Philosophy: An Exposition with Regard to the Natural History of Animals* (1809) trans. Hugh Elliot (Chicago and London: University of Chicago Press, 1984), pp. 106-127.

Bowler and Morus, pp. 129-138 (including Cuvier's response to Lamarck).

Discussion Section: Energy and Progress

March 14-22 Spring Recess: No Class

March 23 Time and Change in Geology

Charles Lyell, *The Principles of Geology, Vol. I* ed. Martin J.S. Rudwick (Chicago and London: University of Chicago Press, [1830] 1990), pp. 1-4 and 75-91.

Bowler and Morus, Chap. 5, "The Age of the Earth," pp. 103-127.

March 25 Charles Darwin's Search for a Vocation

David Young, *The Discovery of Evolution* (Cambridge: Cambridge University Press, 2nd ed., 2007), pp. 102-129.

Bowler and Morus, pp. 137-149.

Discussion Section: Darwin's Predecessors

March 30 The Devil's Chaplain

Film showing: "The Devil's Chaplain," (Timewatch, 1991).

Charles Darwin, *On the Origin of Species* (Cambridge, MA: Harvard University Press, 1964), pp. 1-6, 80-87, 126-130, 459-490.

April 1 Darwin's Theory of Evolution

Craig Baxter (with the Darwin Correspondence Project as research collaborators), "Re: Design – Adaptation of the Correspondence of Charles Darwin, Asa Gray and others....," (2007), 40 pp., <http://www.darwinproject.ac.uk/content/view/89/74/>

Note: Second Take-Home Exam Distributed

Discussion Section: The Origin of Species

April 6 The Reception of Darwin's Theory

Bowler and Morus, pp. 149-162, 341-343 and 354-360.

Ernst Haeckel, *The History of Creation: Or the Development of the Earth and Its Inhabitants by the Action of Natural Causes* (New York: D. Appleton, 1887), pp. 1-23.

April 8 Man, Race and Evolution: The Question of Progress and the Science of Difference

Diane Paul, *Controlling Human Heredity: 1865 to the Present* (Amherst, NY: Humanities Press, 1995), pp. 22-30.

Francis Galton, *Hereditary Genius: An Inquiry into Its Laws and Consequences* (London: Macmillan, 1914; 1st ed. 1869), pp. 325-337.

Discussion Section: Debating Darwin – Knowledge and Social Control

April 13 The Development of the Human Sciences: Measuring Man

Diane Paul, *Controlling Human Heredity: 1865 to the Present* (Amherst, NY: Humanities Press, 1995), pp. 31-49.

Bowler and Morus, Chap. 13, "The Emergence of the Human Sciences," pp. 299-316.

Franz Boas, "Human Faculty as Determined by Race," (1894) in George E. Stocking, Jr., ed. *The Shaping of American Anthropology 1883-1911: A Franz Boas Reader* (New York: Basic Books, 1974), pp. 219-242.

Note: Second Take-Home Exam Due

Part 4: The Laboratory Sciences and the Modern World

April 15 Electricity and Magnetism: Telegraphy and Empire

Bowler and Morus, pp. 403-414.

Bruce J. Hunt, "Doing Science in a Global Empire: Cable Telegraphy and Electrical Physics in Victorian Britain," in Bernard Lightman, ed. *Victorian Science in Context* (Chicago and London: The University of Chicago Press, 1997), pp. 312-333.

Discussion Section: The Human Sciences and The Physics of Empire

April 20 Standards, Networks, and the Rise of the Teaching Laboratory

James Clerk Maxwell, "Introductory Lecture on Experimental Physics," (1871) in *The Scientific Papers of James Clerk Maxwell*, ed. W.D. Niven (Cambridge: Cambridge Univ. Press, 1890), 241-255.

Graeme Gooday, "Precision Measurement and the Genesis of Physics Teaching Laboratories in Victorian Britain," *British Journal for the History of Science* 23 (1990), 25-51.

April 21 Science in the United States: Surveys and Standards

Daniel J. Kevles, *The Physicists: The History of a Modern Scientific Community in America* (Cambridge, MA and London: Harvard University Press, 1995), pp. 25-59.

Discussion Section: Science in the United States

April 27 Rowland and Michelson: Pure and Practical Physics

A.A. Michelson and E.W. Morley, "On the Relative Motion of the Earth and the Luminiferous Ether," (1887) as excerpted in Magie, *Source Book*, pp. 369-377.

H.A. Rowland, "The Highest Aim of the Physicist," (1899) in Spencer R. Weart, ed. *Selected Papers of Great American Physicists* (New York: American Institute of Physics, 1976), pp. 91-103.

April 29 Light and Matter, Time and Space circa 1905: Einstein's Theory of Relativity

Peter Galison, "Einstein's Clocks: The Place of Time," *Critical Inquiry* 26 (2000), 355-389.

John Stachel, "'What Song the Syrens Sang': How did Einstein Discover Special Relativity?" in John Stachel, *Einstein from 'B' to 'Z'* (Boston, Basel and Berlin: Birkhäuser, 2002), pp. 157-169.

Note: Final Take-Home Exam Distributed

Discussion Section: Einstein and the Cultures of Time and Space

May 4 Einstein's Relativity and its Reception

David Cassidy, *Einstein and Our World* (Amherst, NY: Humanity Books, 1998), pp. 35-47.

Albert Einstein, "What is the Theory of Relativity?" (1919) in *The Collected Papers of Albert Einstein, Vol. 7: The Berlin Years: Writings, 1918-1921. English translation of Selected Texts*, (trans.) Alfred Engel, Consultant Engelbert Schucking (Princeton, NJ: Princeton University Press, 2002), pp. 100-104.

May 6 Einstein and the Legacies of the Great War: Concluding Thoughts

Bowler and Morus, pp. 463-468.

G.F. Nicolai, Albert Einstein, and F.W. Förster, "Manifesto to the Europeans," (1914) in *The Collected Papers of Albert Einstein, Vol. 6: The Berlin Years: Writings, 1914-1917. English translation of Selected Texts*, (trans.) Alfred Engel, Consultant Engelbert Schucking (Princeton, NJ: Princeton University Press, 1997), pp. 28-29.

Fritz Stern, "Einstein's Germany," in G. Holton and Y. Elkana, eds. *Albert Einstein: Historical and Philosophical Perspectives* (Princeton, NJ: Princeton University Press, 1982), pp. 319-343.

Discussion Section: Modern Science

Monday May 11 Final Examination Due (12:05 P.M.)

Grading Criteria for Essays

- A: For outstanding essays only. The thesis and argument are clear, thought-provoking, and based on correctly understood facts. Material used to support the argument synthesizes ideas from different parts of the course (readings, lectures, discussions from different weeks). The relationships drawn between facts and ideas are sophisticated, subtle, and/or original. The writing is grammatically correct and succinct, and the argument flows well from point to point. Not a word is wasted!
- AB: For very good essays that for some reason fall short of the criteria described above. The argument may be murky at one point; information may be presented that doesn't directly or clearly contribute to the argument; the writing style may be awkward occasionally, or flawed by one or two consistent (if minor) grammatical errors.
- B: The basic good grade. The essay may pursue a straightforward but not particularly deep or sophisticated argument; it is okay as far as it goes, but doesn't penetrate into the material very far. It may have a flash of brilliance that isn't brought to fruition, because it is counterbalanced by a weakness in argumentation, minor grammatical problems, and/or a significant misunderstanding of events or chronology.
- BC: The essay shows some of the basics of the ideal essay, but is weakened by a lack of serious thinking, or by writing problems. It may make superficial connections without offering sufficient evidence to make the connections plausible or persuasive, or it may have what is in principle a good argument supported by incorrect facts or chronology. Alternatively, it may provide a fairly solid argument with minor flaws, from which the reader is continually distracted by awkward or ungrammatical prose.
- C: A grade signifying some serious problem in essay writing. It may deliver facts without a recognizable thesis or argument; it may wander away from the point; or it may be a thoughtful attempt so weakened by writing problems (grammar, punctuation, word choice) that it is difficult for the reader to understand a crucial point you are trying to make.
- D: A marginal grade. There may be enough here to show that you have attended a few lectures and/or done some of the reading, but the essay indicates no attempt at synthesis or thinking on your own, or shows a serious misunderstanding of the nature of the material and/or the assignment. Also used for essays that are just barely coherent.
- F: For unacceptable essays. An essay may be judged unacceptable if it contains plagiarism; if it consists primarily of content inappropriate to the question or the material for this course; if it shows a complete misunderstanding of the course content; or if the writing fails to meet standard college-level requirements of basic communication in English.

Essays will be predominantly based on course materials, but may make sparing reference to other sources in order to back up an argument.

Plagiarism is grounds for automatic failure on an assignment. If you use three or more words in a row from another source, the phrase must be placed in quotation marks and footnoted. Otherwise it is plagiarism. For more on what constitutes plagiarism and how to avoid it, consult *A Pocket Style Manual* by Diana Hacker, or the UW-Madison Writing Center website.