

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

Spring 2006

3 Credits; N (Natural Sciences), ILS / H (Humanities), Hist. Sci.; E (Elementary)
2 hours lecture (11am TR, 272 Bascom); 1 hour discussion
Open to freshmen; not open to students who have had Hist. Sci. 204

Instructor

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TAs

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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 changing ways that scientific and social values have been interwoven in Western culture. Setting the work of individual scientists in social context the course traces links between ideas, instruments and institutions across both disciplinary and national boundaries. Our studies deliver insight into the changing relations among science and technology, science and religion and science and the state, as we explore the rise of 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, Underground Textbook Exchange, 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 the History of Science Department Office, 7143 Social Science. Note that the office is open from 8 a.m. - 3 p.m. daily, and that all sales are final: NO REFUNDS can be offered even if the class is dropped.

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. 16; due Feb. 23.

Second Take-Home Exam (25%): Distributed March 30; due April 6.

Final Take-Home Exam (30%): Distributed May 4; due 2:25 Fri. May 12.

Honors Assessment

Honors students will work on a project, the details of which will be finalized early in the semester. It will be completed by May 4, 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 one book 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. 17 Introduction and The Natural Machine

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

Jan. 19 Francis Bacon and the Reconstruction of Science

Bowler and Morus, pp. 23-45.

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.

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

Jan. 24 René Descartes on Method

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.

Jan. 26 The New Societies

Bowler and Morus, pp. 319-326.

Discussion Section: Framing the Scientific Revolution (Discussing readings on Bacon, Descartes and the Societies)

Jan. 31 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.

Feb. 2 Mechanics as a Model for Natural Philosophy

Dobbs and Jacob, pp. 34-60.

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

Discussion Section: Newton in his Time

Part 2: From the Enlightenment Experiment to Industrial Revolution

Feb. 7 Newtonianism and the Age of Enlightenment

Dobbs and Jacob, pp. 61-110

Feb. 9 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.

Discussion Section: Enlightenment Electricians

Feb. 14 The Chemical Revolution

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

Frederic L. Holmes, "The 'Revolution in Chemistry and Physics:' Overthrow of a Reigning Paradigm or Competition between Contemporary Research Programs?" *Isis* 91 (2000), 735-753.

Bowler and Morus, Chap. 3, "The Chemical Revolution."

Feb. 16 Electricity and Life

J.L. Heilbron, *Electricity in the 17th and 18th Centuries: A Study in Early Modern Physics* (Mineola, NY: Dover, 1999), pp. xi-xxv.

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

Note: First Take-Home Exam Distributed

Discussion Section: Airs and Gases and the New Chemistry

Feb. 21 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."

Feb. 23 Humboldt's Global Physics

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

Bowler and Morus, pp. 213-224.

Note: First Take-Home Exam Due

Discussion Section: Science and Gender, Travel and the Environment

Feb. 28 Watt and the Steam Engine

D.S.L. Cardwell, *Turning Points in Western Technology: A Study of Technology, Science and History* (New York: Science History Publications, 1972), pp. 60-101.

March 2 The Brewer's Touch and the Mechanical Equivalent of Heat

Heinz Otto Sibum, "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.

Discussion Section: Science and the Industrial Revolution (Energy)

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

March 7 Lamarck's Zoological Philosophy

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.

David Young, *The Discovery of Evolution* (Cambridge: Cambridge University Press, 1992), pp. 81-109.

March 9 Lyell's Principles of 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."

Discussion Section: Darwin's Predecessors

March 11-19 Spring Recess: No Class

March 21 Charles Darwin's search for a Vocation

David Young, *Discovery*, pp. 111-135.

Bowler and Morus, pp. 129-149.

March 23 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.

Discussion Section: The Origin of Species

March 28 Darwin's Theory of Evolution

Robert M. Young, *Darwin's Metaphor: Nature's Place in Victorian Culture* (Cambridge: Cambridge University Press, 1985), "Darwin's Metaphor: Does Nature Select?" pp. 79-125.

March 30 The Scientific Reception of Darwin

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.

Note: Second Take-Home Exam Distributed

Discussion Section: Debating Darwin

April 4 Evolution and the Social Order

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

Diane Paul, *Controlling Human Heredity: 1865 to the Present* (Amherst, NY: Humanities Press, 1995), pp. 22-49.

April 6 Measuring Man

Bowler and Morus, Chap. 13, "The Emergence of the Human Sciences."

Note: Second Take-Home Exam Due

Discussion Section: Knowledge and Social Control

Part 4: The Laboratory Sciences and the Modern World

April 11 Electricity and Magnetism: Telegraphy and the Empire

Bowler and Morus, Chap. 17, "Science and Technology."

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.

April 13 Standards, Networks, and the Rise of Laboratory Training

James Clerk Maxwell, "Introductory Lecture on Experimental Physics," 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.

Discussion Section: The Physics of Empire

April 18 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. 25-74.

April 20 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.

Discussion Section: Science in the United States

April 25 Time and Space circa 1905

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

April 27 Einstein's Relativity and its Reception

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. 157-177.

Bowler and Morus, pp. 253-265.

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

Discussion Section: Einstein and the Cultures of Time and Space

May 2 Einstein and the Legacies of the Great War

Bowler and Morus, pp. 463-468.

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.

May 4 Concluding Thoughts

Note: Final Take-Home Exam Distributed

Discussion Section: Modern Science

Friday May 12 Final Examination Due (12:25–2:25 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.

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.