ARTSSCI 4HS3 – History of Science Inquiry– 2019-20 (Term 2)

Instructor: Matthew Jordan (jordanml@mcmaster.ca)
Office Hours: Wednesdays 3 - 4:30pm, Thursdays 10 - 11am, LR Wilson 3038
Course Time: Tuesdays, 2:30pm - 5:20pm, KTH B-107

Course Description: Science may appear orderly and objective, but its history is messy and deeply human. This course uses case studies—nuclear weapons, scientific racism, and computing, among others—to explore the blunders, biases, and glimpses of brilliance that have defined science over the past 400 years. This historical grounding will then allow us to ask philosophical questions about the meaning of "science," and sociological questions about how scientific knowledge production really works.

Intended Learning Outcomes: At the end of the course, students should be able to:

1. Conduct original historical research from archival and other primary source materials.
2. Appreciate that studying the history of science enables us to understand how science shapes society today.
3. Confidently analyze historic scientific developments at the level of scientists (i.e. lab techniques, new theories), scientific institutions (i.e. what passes peer review), and society at large (i.e. how science is informed by military concerns).
4. Understand contemporary debates about whether science yields objective truth, is socially constructed, has a well-defined method, and ought to be trusted.
5. Communicate clearly and cogently, both in writing and in speech, about science and its history.

Course text: There is no mandatory course text. All readings will be available via the McMaster library database, or in some cases distributed via email.

Course Format: The course has one 3-hour session per week. The first hour will be a lecture, the second hour a seminar-style discussion on the week's readings, and the third hour student presentations. You are expected to do all the scientific & historical readings before each week's class. Much of the scientific reading is quite technical; feel free to skip the equations. You will get *much* more out of the course if you do the readings ahead of time, so please do your best to come to class prepared.

A Note on Time and Space: The history of science is an impossibly vast subject and a course like this can cover only a vanishingly small fraction. I have chosen to focus on key milestones in the past 400 years of Western science, simply because that's what I know best. However, you are encouraged to explore any eras or geographies in your essays.

Lecture Schedule

January 7 — From The Closed World to the Infinite Universe

The overthrow of geocentrism; questioning every word in "the" "scientific" "revolution."

Scientific Background:

1. Nicolaus Copernicus, *De Revolutionibus Orbium Coelestium* (1543) — Preface, Forward, Introduction, and Book 1.
2. Galileo Galilei, *Dialogue Concerning the two Chief World Systems* (1632), trans. Stillman Drake — Forward, Preface, Dedication, First Day.

Historical Analysis:

1. Alexandre Koyré, "Galileo and the Scientific Revolution of the Seventeenth Century", *The Philosophical Review* (1943).
2. Roy Porter, "The Scientific Revolution: A Spoke in the Wheel?" in Roy Porter and Mikulas Teich, *Revolutions in History* (Cambridge University Press: 1986).
3. David C. Lindberg, "Conceptions of the Scientific Revolution from Bacon to Butterfield: A Preliminary Sketch" in David S. Lindberg and Robert S. Westman, "Reappraisals of the Scientific Revolution" (Cambridge University Press: 1990).

January 14— Scientific Institutions and Empire

How science contributed to empire-building, and colonialism supported science in turn.

Scientific Background:

1. Francis Bacon, *The New Atlantis* (1623).
2. Francis Bacon, *Novum Organon* (1620), trans. James Spedding — Forward, Dedication, Preface.

Historical Analysis:

1. Harry Redner, "The institutionalization of science: a critical synthesis", *Social Epistemology* (1987).
2. Mark Harrison, "Science and the British Empire", *Isis* (2005).
3. Helen Tilley, "Racial Science, Geopolitics, and Empires: Paradoxes of Power", *Isis* (2014).

January 21 — Medicine: The Greatest Benefit to Humankind

The transformation in our self-understanding and the incredible rise of medicine.

Historical Analysis

1. Roy Porter, *The Greatest Benefit to Mankind* (W.W. Norton & Company, 1997) — Chapters 3, 9, 10, 11.

January 28 — Darwin, Galton, and Eugenics

How Charles Darwin synthesized geology, biology, and economics to develop his theory.

Scientific Background:

1. Charles Darwin, *The Descent of Man, and Selection, in Relation to Sex* (1871) — Introduction, On the Races of Man, Secondary Sexual Characters of Man.
2. Charles Darwin, *On the Origin of Species* (1859) — Introduction, Conclusion

Historical Analysis:

1. Peter J. Bowler, "Darwin's Originality", *Science* (2009).
2. Silvan S. Schweber, "The Origin of the *Origin* Revisited" (1977).
3. David R. Oldroyd, "Charles Darwin's Theory of Evolution: A Review of our Present Understanding" (1986).
4. Diane B. Paul, "Darwin, Social Darwinism and Eugenics" in Jonathan Hodge and Gregory Radick, *The Cambridge Companion to Darwin* (Cambridge University Press, 2003).

February 4 — Two Revolutions in Physics

The observations, theories, and social forces that led to relativity and quantum mechanics.

Scientific Background:

1. Albert Einstein, "On The Electrodynamics of Moving Bodies", *Annalen der Physik* (1905).
2. Niels Bohr, "On the Constitution of Atoms and Molecules", *Philosophical Magazine* (1913).
3. Werner Heisenberg, "Quantum-Theoretical Re-Interpretation of Kinematic and Mechanical Relations", *Zeitschrift für Physik* (1925).

Historical Analysis:

1. Olivier Darrigol, "Quantum Theory and Atomic Structure, 1900 - 1927", in Mary Jo Nye *The Cambridge History of Science* (2002).
2. Peter Galison, "Einstein's Clocks: The Place of Time", *Critical Inquiry* (2000).

February 11 — The Manhattan Project and Big Science

"Deep things in science are not found because they are useful; they are found because it was possible to find them."

Scientific Background:

1. Lise Meitner and Otto Frisch, "Disintegration of Uranium by Neutrons: a New Type of Nuclear Reaction", *Nature* (1939).
2. Otto Frisch, "Physical Evidence for the Division of Heavy Nuclei under Neutron Bombardment", *Nature* (1939).
3. Rudolf Peierls and Otto Frisch, "On the Construction of a "Super-bomb"; Based on a Nuclear Chain Reaction in Uranium" (1941).

Historical Analysis:

1. Jeff Hughes, *The Manhattan Project: Big Science and the Atom Bomb* (Columbia University Press, 2002) — Chapters 4 - 7.

February 25 — Cracking the Human Code

The rise of genetics and the largest-ever scientific collaboration, the Human Genome Project.

Scientific Background:

1. James Watson and Francis Crick, "Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid", *Nature* (1953).
2. Aaron Klug, "Rosalin Franklin and the Discovery of the Structure of DNA", *Nature* (1968).

Historical Analysis:

1. Jean Gayon, "From Mendel to Epigenetics: History of Genetics", *Comptes Rendus Biologies* (2016).
2. Daniel Kevles, "Eugenics, the Genome, and Human Rights", *Medicine Studies* (2009).
3. Daniel Kevles, "Big Science and Big Politics in the United States", *Historical Studies in the Physical and Biological Sciences* (1997) — the sections on the HGP.

March 3 — Environmental Science and its Critics

The decades-long effort to undermine and the scientific consensus on climate change.

Scientific Background:

1. Naomi Oreskes, "The Scientific Consensus on Climate Change: How Do We Know We're Not Wrong?", *Climate Modelling* (2018).

Historical Analysis:

1. Naomi Oreskes, Erik M. Conway, and Matthew Shindell, "From Chicken Little to Dr. Pangloss", *Historical Studies in the Natural Sciences* (2008).
2. Robert Kenner, *Merchants of Doubt* (Mongrel Media Inc., 2014) — Documentary.
3. Paul N. Edwards, "Global climate science, uncertainty and politics: Data-laden models, model-filtered data", *Science as Culture* (1999).

March 10 — Artificial Brains and Artificial Minds

Artificial intelligence, cybernetics, and radical ideas that birthed our information age.

Scientific Background:

1. Arturo Rosenbluth, Norbert Wiener, Julian Bigelow, "Behavior, Purpose, and Teleology", *Philosophy of Science* (1943).
2. Alan Turing, "Can Computers Think?", *Mind* (1950).

Historical Analysis:

1. Ronald Kline, "Cybernetics, Automata Studies, and the Dartmouth Conference on Artificial Intelligence", *IEEE Annals of the History of Science* (2010).
2. Nathan Ensmenger, "Is Chess The Drosophila of Artificial Intelligence?", *Social Studies of Science* (2011).
3. Mikel Olazaran, "A Sociological Study of the Official History of the Perceptrons Controversy", *Social Studies of Science* (1996).

March 17 — How Does Science Work?

A variety of thinkers' views on what "science" is and whether it has a fixed method.

1. AF Chalmers, *What is this Thing Called Science?* (Hackett Publishing Company, 1999, 3ed.) — Introduction & Chapter 1
2. Imre Lakatos, "Science and Pseudoscience", BBC Radio Talk (1973).
3. Thomas Kuhn, "Rationality, Objectivity, and Values in Science", in Thomas Kuhn, *The Essential Tension* (University of Chicago Press, 1977).
4. Karl Popper, "Science: Conjectures and Refutations", in Karl Popper, *Conjectures and Refutations* (1963).
5. Feyerabend, "How to Defend Society Against Science", *Radical Philosophy* (1975).
6. Merton, "The Normative Structure of Science" (1943)

March 24 — The Production of Scientific Knowledge

How do scientists take results from test tubes and turn them into widely accepted facts?

1. Harry Collins, "The Seven Sexes: A Study in the Sociology of a Phenomenon, or the Replication of Experiments in Physics", *Sociology* (1975).

2. Bruno Latour & Steve Wolgar, *Laboratory Life* (Princeton University Press, 1976) — Chapter 6.
3. Donald Mackenzie and Graham Spinardi, "Tacit Knowledge, Weapons Design, and the Uninvention of Nuclear Weapons", *American Journal of Sociology* (1995).

March 31 — Critiques of Science and the -isms Wars

Various criticisms of science and the Science Wars of the 1990s.

1. Alan Sokal, "A Physicist Experiments with Cultural Studies", *Lingua Franca* (1996)
2. Ian Hacking, *The Social Construction of What?* (Harvard University Press, 2000) — Preface & Chapter 1.
3. Bruno Latour, "Why Has Critique Run Out of Steam?", *Critical Inquiry* (2004).
4. Maralee Harrell, "On the Possibility of a Feminist Philosophy of Physics", *Meta-Philosophical Reflection on Feminist Philosophies of Science* (2016).
5. Evelyn Fox Keller, "Gender and Science: An Update" in Mary Wyer et al. *Women, Science, and Technology* (Routledge, 2001).

April 7 — Review & Essay Work

Summarizing the course material and an opportunity to ask questions/edit your final essay.

Evaluation

Assignments should be emailed to jordanml@mcmaster.ca by midnight on their due date. A late penalty of 5% per day will be deducted from assignments submitted after the deadline.

Assignment	Length	Due Date	Grade Weight
Archival Research Essay	1500 words	January 21st	15%
Class Presentation	20 minutes	Throughout term	15%
Class topic essay	1500 words	One week after presentation	15%
Final Paper	4500 words	April 10th	45%
Participation	–	–	10%

Archival Research Essay | Due January 21 | 15%

In the first two weeks of class, you will write a 1500-word essay primarily using resources from the Bertrand Russell Archives. You should pick a topic, person, or scientific area of interest related to Bertrand Russell and search the Bertrand Russell Archives Catalogue Entry and Research System (BRACERS) database for materials related to that topic. You can find the entire list of materials on the BRACERS correspondence page. Once you have found items that you want to view, you should

send an email to archives@mcmaster.ca with the collection code, class number, document number, and box number for those items, and arrange a time to visit the archives.

Potential people whose correspondences might make for a fruitful essay include Albert Einstein, Alfred North Whitehead, Herbert Simon, Niels Bohr, Robert & Frank Oppenheimer, Gottlob Frege, Leo Szilard, and William James. You can also write about scientific topics that Russell devoted his life to, like the foundations of mathematics or nuclear disarmament.

Your essay should begin with an introduction to Russell and the correspondent/topic you are investigating. You should use secondary source material (for instance, the Stanford Encyclopedia of Philosophy, or reputable sources you find cited on Wikipedia) for this section. You should then introduce your specific topic, and the bulk of your essay should engage with the archival resources. For instance, you could write an essay on Russell's commentary on the computer program "The Logic Theorist," an early AI program designed to prove statements in Russell's book *Principia Mathematica*. You would begin by sketching a brief introduction to The Logic Theorist, then write about Russell's response to the program using archival letters between Russell and Herb Simon, one of the program's creators.

The goal of this assignment is to introduce you to the process of doing archival research. In many cases, the archival documents you find will be incomplete, or you will only be able to see one side of the correspondence. That's ok! Feel free to mention these deficits in your essay. I am grading the quality of your essay, not the quality of the archival documents you draw upon.

When visiting the archives, you should make note of the number of every document you read, so that you can cite it appropriately in your essay. History research is meant to be reproducible: the reader should be able to easily locate every document you cite, so make sure you cite consistently and comprehensively. The particular citation style you use is not important, though most historians use Chicago Style.

Class Presentation | Throughout Term | 15%

You will deliver a 20-minute presentation on a topic related to the readings for that week's class. You are free to take this presentation in any direction you choose, based on any reading, or any other material you find about the topic. For instance, for the week on the Manhattan Project, you can choose to write about the discovery of plutonium, the role of women in the Manhattan Project, the life of the spy Klaus Fuchs, the reorganization of the government necessary to build the bomb, or the decision to drop the bomb.

In your presentation, you should discuss both the history of the topic, and the historiography—that is, the historical literature written about the topic. You should begin by presenting the history, and then discuss the open questions, key disputes, or general focus of the historiography. For instance, if you are presenting on the birth of eugenics, you could spend the first 15 minutes discussing the work of Francis Galton, and the last 5 minutes talking about historical scholarship on Galton, which began in the 1970s with the work of Ruth Schwartz Cowan and is evolving to the present day.

In the first lecture, we will pick dates for the presentations. These presentations will take place during the third hour of class, and will be followed by a class discussion. Most classes will have two presentations, and those presentations should not be on the same topic.

Class Topic Essay | One Week After Your Presentation | 15%

One week after your presentation, you will submit a 1500-word essay on the topic of your presentation. Your essay should summarize the main discussion points of the presentation, and incorporate both history and historiography.

Final Paper | 45%

Your final paper consists of a 4,500-word essay on any topic of your choosing related to the course material. I must approve your topic by **February 25th**, but given the breadth of what's covered under "history of science," I'm likely to approve most suggestions.

Your essay should consider your chosen topic from a variety of perspectives, from an "internalist" view of scientists' work to an "externalist" view of that work's place in society. It should also address the historiography of the topic. For instance, if you are writing about Alan Turing's role in AI, you should describe Turing's paper on whether machines can think, his design of the National Physical Laboratory's ACE computer, the political and military circumstances that made such a computer necessary, and the fact that Turing was not widely known or appreciated until Andrew Hodges' 1983 biography.

Most professional historians do not write this way—they usually stick to one register, focusing exclusively on technical matters or societal concerns, but not both. But most professional historians were not trained in Artsci. You are in a unique position to seamlessly blend these different types of historical analysis, and your essay ought to demonstrate that technical and societal factors are inseparable. The influence goes both ways: societal trends shape the scientific community's research priorities, and scientific ideas shape society in turn.

If you're stuck, there are many sources you can turn to for inspiration on how this style of history is written. Some examples of books are:

- Andrew Hodges, *Alan Turing: The Enigma*, 1983
- Rhicard Rhodes, *The Making of the Atomic Bomb*, 1986
- Rebecca Skloot, *The Immortal Life of Henrietta Lacks*, 2010

I'm also happy to give recommendations for your particular topic!

Your essay should include an abstract, a table of contents, and clear, consistent citations. You should feel free to dig into primary or archival resources—for instance, many universities have put scanned versions of their archives online. Your essay should be framed as the answer to a research question (i.e. "What was the role of telescopes and microscopes in the scientific revolution?"), an argument (i.e. "I will argue that the consensus on cigarettes was undermined by a small group of politically-motivated scientists"), or a narrative (i.e. "This essay tells the story of how phlogiston theory was overturned").

Participation | 10%

This is a small seminar-style class, which means we'll be spending a lot of time discussing and dissecting texts. Your participation grade is based on whether you come to class prepared to engage with the material each week. You don't need to be the most vocal person in the room; the important thing is that you've put in the work. Asking questions is just as important as answering them!

McMaster Policy on Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences—e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty, please refer to the Academic Integrity Policy, located at: http://www.mcmaster.ca/academicintegrity.

The following illustrates only three forms of academic dishonesty: 1) Plagiarism—e.g., the submission of work that is not one's own or for which other credit has been obtained. 2) Improper collaboration in group work. 3) Copying or using unauthorized aids in tests and examinations.

McMaster Student Absence Form (MSAF)

In the event of an absence, students should review and follow the Academic Regulations in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work." Please consult the MSAF statement on our website (https://artsci.mcmaster.ca/forms-requests/) and direct any questions or concerns to Shelley Anderson or Madeline Van Impe in the Arts & Science Program Office.

Academic Accommodation of Students with Disabilities

Students who require academic accommodations must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. SAS can be contacted by phone 905-525-9140 ext. 28652 or email sas@mcmaster.ca. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous, or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request to their Faculty Office (i.e. to Shelley Anderson or Madeline Van Impe in the Arts & Science Program Office) normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Email Contact and Student Responsibility

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L, and/or McMaster email. It is the responsibility of students to check their McMaster email and course websites regularly during the term and to note any changes. Announcements will be made in class and by using the course email distribution list.