Description

From the course catalog:

A study of the philosophical problems that arise in the sciences: how claims are justified, the limits and styles of explanation, identifying pseudoscience, values in science, unity and diversity of the sciences, and science's impact on our world view. 3 units.

In more detail:

Philosophy of science involves more than just the study of the philosophical problems inherent in the nature and methodology of scientific reasoning, which are topics we will explore in this course; it also involves the study of the conceptual and philosophical foundations, presuppositions, and implications of the theories that form the core framework by which the physical world is understood by the natural sciences in general. Whatever one might say of this framework, in the practice of modern science, it is understood to be physically causal, conceptually logical, and mathematically describable--yet impossible to reduce fully to any of these features. This provides an important clue to their relationship in both the philosophy and practice of modern science, and is a central topic in this course.

Requirements

Our work will primarily be lecture and discussion, so both careful attention to the readings and class participation will be crucial for a lively course. Always bring your texts to class.

EXAMINATIONS

There will be two examinations--one take-home mid-term paper and one in-class final--as well as several unannounced short answer quizzes on the readings. All written work must comply with Philosophy Department guidelines, which can be found here. The departmental grading policy for written work can be found here.

PHONES AND COMPUTERS

Phones, laptops, tablets, and all other electronic multi-media devices are NOT permitted in class. For my reasoning, please refer to my colleague Dr. Merlino's excellent explanation.

POWERPOINT PRESENTATIONS AND PRE-OUTLINED LECTURES

I do not use these in my courses (other than for the occasional diagram, table, graph, or some other image of this kind.) The ability to listen attentively to a lecture or discussion, follow its structure, identify its key points, and take proper notes, is crucial. If this is done for you via Powerpoint slides, or lecture outlines (whether pre-distributed or written on the chalkboard), you are denied the
opportunity to exercise and strengthen this ability, or develop it in the first place if you haven't already. It is not difficult, but requires effort. Whatever your intended profession, this is an ability that you will need, and one that many employers lament is deficient or even non-existent in recent college graduates.

For other arguments against Powerpoint-based lectures, including scientific studies demonstrating their hazards, see this [article](https://www.edwardtufte.com/v0/tufte/articles/) by Edward Tufte, Professor Emeritus of Political Science, Computer Science and Statistics, and Graphic Design at Yale University; see also this [article](https://www.jstor.org/stable/27832830) on the work of Dr. John Sweller, University of New South Wales. Finally, see the following [paper](https://www.jstor.org/stable/3290901) by R. Mayer, J. Heiser, and S. Lonn, "Cognitive Constraints on Multimedia Learning: When Presenting More Material Results in Less Understanding." *Journal of Educational Psychology*. Vol. 93:1 (2001): 187-198

**ATTENDANCE**

Given the above, it is impossible to succeed in this course if you miss the lectures. To encourage attendance, students are permitted only 2 unexcused absences.

**Note:** Anyone who misses 2 lectures in the first 2 weeks of class will be administratively dropped per CSUS policy. This is to make room for serious students who are attempting to add.

**Texts and Materials**

  
  **Note:** The actual title of this book, in the original French, is *Philosophie de la Science Contemporaine*, or "*Contemporary Philosophy of Science*." The "Quantum Philosophy" bit was added to the English translation for marketing purposes. (The thinking behind this is one of the problems we will discuss in this course.)


- Other selected readings will be listed in the lecture schedule (below) and made available electronically via the course's Downloads Page.

**Grading**

Class participation: 15%  
4 or more unexcused absences results in 0%.

Quizzes: 25%  
These are written pop quizzes on the reading assignments.

Mid-term exam: 25%

Final exam: 35%

**Academic Standards:** All sources in papers must be cited and given appropriate credit. The author of any information from the Internet must be given credit; using such information without indicating the source constitutes plagiarism, as it would with print publications. Students are allowed to discuss lectures and even assignments with each other, but they must do their own work. Students are required to read the University policy on academic honesty, which can be found [here](https://www.csus.edu/academics/academic-policy-and-procedures/academic-honesty-policy).
**Students with Disabilities:** If you have a documented disability and require accommodation or assistance with assignments, tests, attendance, note taking, etc., please see the instructor during the first week of the semester so that appropriate arrangements can be made to ensure your full participation in class. Also, you are encouraged to contact the Services for Students with Disabilities (Lassen Hall) for additional information regarding services that might be available to you.

**Lecture Schedule**

**Week 1**

**Monday**

8/27

General introduction and background: 'Epistemic claims vs. ontological claims'--an old dualism in philosophy that is no longer easily sustainable, particularly when applied to quantum theory--our most fundamental physical theory. In light of the latter, for example, 'logical relations' are no longer summarily definable as purely epistemic structures, derivative of the human mind alone; in quantum mechanics, logical relations are ontologically and physically significant structures that cannot be reduced to human mentality. Aside from the conventional 'observer-free' interpretations of quantum mechanics, the clearest exemplification of this can be found in quantum cosmologies that depict the universe as generated ex nihilo(from 'nothing')--that is, from a state wherein nothing exists apart from the logical relations constitutive of the laws of quantum mechanics. It is, in other words, a primordial state of logical relations without physical relata--and in that sense, logic cannot be 'merely' epistemic. Readings: (Handed out in class)


Ross Anderson. "Has Physics Made Philosophy and Religion Obsolete?" Interview of Lawrence Krauss. The Atlantic Monthly (23 April 2012) - [Download](#)

A brief discussion of quantum cosmology: The scientific and philosophical problems of models with and without singularities and boundary conditions. These problems include:

- defining 'nothing'
- the fact of initial conditions (first principles)
- defining 'probabilities' quantum mechanically (via statistical ensembles) in a single universe.

**PART I: ISSUES IN THE METHODOLOGY OF SCIENTIFIC REASONING: A LOOK AT MODERN PHYSICS**

**Wednesday**

What is a scientific law, and what is its role in scientific explanation? Presumption of regularities; counterfactuals; context dependence; boundary conditions; the deductive-nomological (D-N) model.

The Law of Gravitation - An Example of Physical Law

Reading: Feynman, Introduction and Chapter 1: pp. 11-34
**Week 2**

**Monday**

Induction, statistics, and probability; deduction and the hypothetico-deductive method.

Reading: "The Relation of Mathematics to Physics" - Feynman, Chapter 2: pp. 35-58

**Wednesday**

Falsifiability; underdetermination and the Quine-Duhem thesis

Reading: "The Relation of Mathematics to Physics" - Feynman, Chapter 2: pp. 35-58

(continued)

**Week 3**

**Monday**

Scientific realism vs. antirealism; theories and models.

Reading: "The Great Conservation Principles" - Feynman, Chapter 3: pp. 59-83

**Wednesday**

Concepts to be introduced: Semantic vs. syntactic approaches to theories and models.

Reading: "Symmetry in Physical Law" - Feynman, Chapter 4: pp. 84-107

**Week 4**

**Monday**

This week, we will revisit all the concepts introduced so far as they pertain to the concept of time—viz. its definition and application in modern science (e.g., reversible vs. irreversible dynamics in physics).

This topic is crucial because it exemplifies the central problem in philosophy of science: Understanding the relationship between logic and causality.

Reading: "The Distinction Between Past and Future" - Feynman, Chapter 5: pp. 108-126

**Wednesday**

Time, Logic, and Causality (continued)

Reading: "The Distinction Between Past and Future" - Feynman, Chapter 5: pp. 108-126

(continued)

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**PART II: THE LEGACY OF THE CLASSICAL WORLDVIEW AND ITS EXEMPLIFICATION IN CLASSICAL LOGIC, PHYSICS AND MATHEMATICS**

**Week 5**

**Monday**

An Overview of Classical Logic: Pythagoras; Plato's 'logos'; Aristotle; paradoxes in classical
logic; the concept of 'universals.'

Reading: Omnès, Prelude and Ch. 1: pp.xv-22

**Wednesday**

An Overview of Classical Physics: The lineage from astronomy (Hipparchus to Kepler) to mechanics, then Newtonian dynamics, then the breakthrough of electromagnetism, and the philosophical significance of Maxwell's Equations.

Reading: Omnès, Ch. 2: pp.23-46

### Week 6

#### Monday

An Overview of Classical Mathematics

Reading: Omnès, Ch. 3: pp.47-61

#### Wednesday

An Overview of Classical Epistemology

Bacon and induction; Descartes and deduction; Locke and empiricism; Hume and Kant

Reading: Omnès, Ch. 4: pp.62-78; Excerpts from Bacon's New Organon (available from the course downloads page.)

### PART III: CHALLENGES TO CLASSICALITY AND THE RISE OF FORMALISM IN PHYSICS AND MATHEMATICS

#### Week 7

#### Monday

Formal Mathematics: Logic, symbols, and sets; propositions

Reading: Omnès, Ch. 5: pp.84-92

#### Wednesday

Formal Mathematics (cont’d): Infinity; problems in set theory; Gödel's incompleteness theorem

Reading: Omnès, Ch. 5: pp.93-108

#### Week 8

**MIDTERM DISTRIBUTED - NO CLASS THIS WEEK: I will be away at a conference.**

#### Week 9

#### Monday

The Philosophy of Mathematics: Mathematical realism; mathematical nominalism
Reading: Omnès, Ch. 6: pp.108-118

**Wednesday**

The Philosophy of Mathematics (continued): Mathematical sociologism; mathematics and physical reality

Reading: Omnès, Ch. 6: pp. 118-123

MIDTERM COLLECTED

**Week 10**

**10/29**

**Monday**

Formal Physics: Relativity; the Relativistic Theory of Gravitation

Reading: Omnès, Ch. 7: pp. 124-133

**Wednesday**


Reading: Omnès, Ch. 7: pp.134-146

**Week 11**

**11/5**

**Monday**


Reading: Omnès, Ch. 8: pp.147-151

**Wednesday**

Epistemology and modern physics (continued): Bohr's principle of complementarity; the collapse of the wave function.

Reading: Omnès Ch. 8: pp.152-158

**PART IV: THE QUEST FOR COHERENCE IN THE PHILOSOPHY OF SCIENCE: REDISCOVERING CLASSICAL LOGIC (AND 'COMMON SENSE') IN FUNDAMENTAL PHYSICS**

**Week 12**

**11/12**

**Monday**

Re-discovering the relevance of classical logic in quantum theory: understanding classical vs. quantum observables, the function of classical logic in both cases.

Reading: Omnès, Ch. 9: pp.159-174

**Wednesday**
Re-discovering the relevance of classical logic in quantum theory (continued): quantum histories, probabilities, and distinction between quantum logic and classical logic.

Reading: Omnès, Ch. 9: pp.174-183

**Week 13**  
11/19

Monday

Re-discovering common sense in measurement: indeterminacy and determinism; quantum interference; decoherence and its connection to classical logic

Reading: Omnès, Ch. 10-11: pp.184-202

Wednesday

Re-discovering common sense in measurement (continued): the physical meaning of the wavefunction and decoherence; the logical meaning of decoherence; the connection of decoherence and the direction of time.

Reading: Omnès, Ch. 11: pp. 202-215

**Week 14**  
11/26

Monday

Re-examining realism in light of quantum theory: realism vs. rationality; quantum physics and realism; 'ordinary' vs. 'quantum' reality

Reading: Omnès, Ch. 12: pp. 216-224

Wednesday

Re-examining realism in light of quantum theory (continued): the EPR experiment and quantum nonlocality; Bell's Theorem and the Aspect experiments; realism and quantum histories--the main arguments and controversies.

Reading: Omnès, Ch. 12: pp. 224-234

**Week 15**  
12/03

Monday

Progress in philosophy of science: Moving forward...

Reading: Omnès, Ch. 13: pp. 235-240; Ch. 16: pp.269-282

Wednesday

Review and outlook.

Re-read the Anderson interview with Lawrence Krauss from Week 1: Re-evaluate Krauss's assessment of the relationship between philosophy, mathematics, and physics.

12/8-14 **Final Exam** (TBA)