

Santa Clara University
Department of Electrical Engineering
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Winter 2016

ENGR 143H Science, Religion and the Limits of Knowledge

REQUIRED READING

1. Aleksandar I. Zecevic, *Truth, Beauty and the Limits of Knowledge: A Path from Science to Religion*, University Readers, 2012.
2. John Haught, *Science and Religion: From Conflict to Conversation*, Paulist Press 1995.
3. John Polkinghorne, *Belief in God in an Age of Science*, Yale University Press, 1998.

COURSE OBJECTIVES AND SCOPE

There is a widespread belief among scientists and engineers that science and religion are essentially unrelated areas of human inquiry. According to this outlook (which is sometimes referred to as the ‘doctrine of non-overlapping magisteria’), science ought to limit itself to factual questions about nature, and religion should deal with issues related to meaning and value. As long as this distinction is observed, there is no apparent reason why the two disciplines should not coexist peacefully.

Although this approach provides a sensible compromise, there seems to be something rather artificial in such a strict separation. Indeed, since religion represents a global view of the world, it must necessarily make claims that concern nature and our place in it. As such, it is bound to address a variety of issues that are of interest to science (evolution and the creation of the universe come to mind immediately). If we are, therefore, inclined to be realistic (as scientists and engineers ought to be), we should assume that there is a certain amount of overlap between theology and science, and consider the consequences.

The main purpose of this course is to examine a number of key theological claims, and evaluate whether they have a rational justification from a scientific perspective. In thinking about what the term “rational” means in this context, it is useful to recognize that our actions and opinions are guided by what physicist (and historian of science) Gerald Holton describes as a “robust, map-like constellation of ... beliefs about how the world as a whole operates.” He refers to this overall outlook that shapes our attitudes as a *Weltbild* (which is a somewhat broader German word for “world view”).

Although the *Weltbild* of any given individual depends to a large extent on his or her social, ethnic and educational background, it is fair to say that it always contains a subset of beliefs that pertain to the natural world. It is perhaps here that we might locate an appropriate meaning for the attribute “rational,” at least when it comes to scientifically minded individuals. It is reasonable to assume that for such a person, a coherent world view would be one that satisfies the following two conditions:

1) The set of “core” beliefs about the natural world must be compatible with existing scientific knowledge.

2) The “non-scientific” core beliefs should be consistent (at least in some measure) with the scientific ones.

In applying these criteria, it is important to keep in mind that the term “consistent” must be used somewhat loosely. Indeed, I seriously doubt that the entire mindset of any individual could pass a strict test of logical soundness (which is perhaps what makes us human in the first place). With that in mind, one could argue that the rationality of our *Weltbild* can be justified by establishing appropriate “logical bridges” between the disparate clusters of views that constitute it. Formal reasoning is of little use in this enterprise, and should ultimately give way to analogies and metaphors.

What is it about analogies and metaphors that makes them so suitable for this purpose? The primary motive for focusing on these two modes of description stems from the fact that they have always been a natural tool for explaining difficult concepts, both in science and in theology. If these two disciplines are seen as manifestations of the same overarching reality (as Christian theology suggests), then it is perfectly reasonable to assume that analogies can also help bridge the apparent gap that separates them. From a theological perspective, what we are really proposing here amounts to adding a certain number of “scientific” metaphors to the already existing traditional ones. The potential value of such metaphors has been recognized by several contemporary thinkers:

“Metaphors ‘fund’ theology, providing the language and images out of which theological concepts grow; they describe the unknown in terms of the known. ... When metaphors lose their original meaning and fruitfulness, the theology built upon them must be reconstructed, drawing upon new metaphors appropriate for a new age... It seems reasonable that physics, as well as biology and the other sciences which infuse our culture, can be a source of religious metaphors.” *Robert J. Russell*

In order to draw the appropriate analogies, it will be necessary to consider a number of scientific theories in some detail. Our primary focus will be on nonlinear systems and chaos theory, which will be the subject of the four technical projects. We will also discuss metamathematics, quantum mechanics, relativity and string theory, but in a way that is much less formal. As you learn more about these topics, you will gain insights into some of the most perplexing phenomena that modern science has discovered. It is important to keep in mind, however, that acquiring this kind of knowledge is *not* the primary objective of this class. It is more appropriate to think of it as a “tool” that will help you get a better understanding of some of the theological and philosophical issues that will be raised.

Recognizing that the subtle workings of nature are often strange and thoroughly counterintuitive is, of course, interesting in its own right, but it ought to excite a sense of wonder that goes well beyond mere scientific curiosity. It is my hope that you will experience this feeling, and that you will continue to pursue this line of inquiry long after your formal education is completed.

CORE LEARNING OBJECTIVES FOR RTC 2

1. Students will analyze complex and diverse religious phenomena (such as architecture and art, music, ritual, scriptures, theological systems, and other cultural expressions of religious belief).
2. Students will be able to integrate and compare several disciplinary approaches to a coherent set of religious phenomena.
3. Students will be able to clarify and express beliefs in light of their critical inquiry into the religious dimensions of human existence.

How the Core Learning Objectives will be Evaluated

Core Objective 1 → Writing Assignments 2 and 4

Core Objective 2. → Writing Assignments 1 and 3

Core Objective 3. → Final Essay and Class Discussions

LEARNING OUTCOMES

Students who successfully complete this course should be able to:

1. Simulate the dynamic behavior of continuous and discrete systems using an appropriate mathematical software package.
2. Analyze the stability properties of linear and nonlinear dynamic systems.
3. Identify the different types of attractors that can arise in nonlinear systems.
4. Distinguish between complex dynamics and purely random behavior.
5. Grasp the philosophical and theological implications of chaos theory, in the context of phenomena such as intermittency and hypersensitivity to initial conditions.
6. Understand the interplay between chance and lawful behavior in complex systems, particularly as it pertains to the emergence of novel forms of organization in nature.
7. Understand the epistemological limitations of scientific explanations, and relate this knowledge to the theological method of inquiry.
8. Reflect on their own views about religion and relate them to their scientific training.

Outcomes 1 – 4 will be evaluated through the four technical projects. Items 5 – 8 will be assessed through the writing assignments, class participation and the final essay.

HOW THE COURSE IS ORGANIZED

Non-Technical Topics

The non-technical topics covered in this course are grouped into four modules:

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| Module 1 | The Limits of Scientific Knowledge (Weeks 1 – 3) |
| Module 2 | Fundamental Theological Questions (Weeks 4 – 5) |
| Module 3 | Controversial Issues: Miracles, Evolution and Religious Pluralism
(Weeks 6 – 8) |
| Module 4 | The True, the Good and the Beautiful (Weeks 9 – 10) |

Each module will have a short writing assignment (1 – 2 pages). There will also be an 8 – 10 page final essay, which will be due on the first day of finals week. A more detailed description is provided below.

Writing Assignments

Assignment 1: In the first assignment you will be asked to reflect on the limitations of scientific explanations, based on what you have learned about quantum mechanics, metamathematics and chaos theory. I would also like you to explain what the term “mystery” means to you personally, and whether you think there is room for this notion in the context of science. If so, would you say that this is a possible “point of contact” between science and religion?

Assignment 2: In the second assignment, you will be asked to examine the relationship between faith and reason, based on what you have learned about Christian theology. I would like you to consider whether it makes sense to describe God using attributes such as omnipotence and omniscience, and whether the notion of “existence” applies to God in a meaningful way. I would also like you to elaborate on the differences (and possible similarities) between the scientific and theological methods of inquiry. Do you think that science is in some way “superior” to theology because it relies on measurable data and repeated experiments? Or would you argue that the methods of any given discipline are dictated by the nature of the problems it investigates?

Assignment 3: In the third assignment, you will be asked to examine whether a scientifically educated individual can rationally accept certain controversial religious teachings, such as the existence of miracles, the “purposefulness” of evolution and the claim that some religious traditions reflect the truth more accurately than others. Pick one of these three issues, and articulate your own views about it. Do you think the scientific and theological positions on this issue can somehow be reconciled?

Assignment 4: In the fourth assignment, you will be asked to reflect on how beauty and the possibility of doing good have influenced your choice of profession. You will also be asked to discuss how you see the relationship between beauty and truth, and why aesthetic criteria have been such a useful guide for new scientific discoveries. Do you agree with the way theologians interpret this connection? If not, what alternative explanations do you favor?

Class Participation. Each of the four modules will require some preliminary reading on your part (the relevant sections in *Truth, Beauty and the Limits of Knowledge* are indicated in the description of the individual lectures). Although I will review these topics and clarify the main concepts, I will expect you to come prepared. The emphasis in this component of the course will be on class discussions, and the amount of credit given (from 0 – 15%) will depend both on the frequency and the quality of your comments, questions and observations.

Final Essay. In the final essay, you will be asked to provide your views regarding the relationship between science and religion. You are expected to select one of topics discussed in class and expand on it. You may combine several topics or perhaps propose some of your own; however, all such modifications will be subject to approval by the instructor. The essay should include the theoretical background for your discussion, as well as an explanation for your choice of topic (I would like to know why a particular question is more interesting to you than some others). *I will also expect you to elaborate on how the theological and philosophical positions proposed in Haught's and Polkinghorne's books relate to your arguments.*

The paper should be 8-10 pages long, and will be due on the first day of finals week. The specific claims and opinions that you choose to express in the essay are entirely up to you (bear in mind that agreeing with me won't get you any extra points!). You will be graded on the quality of your arguments and your understanding of the material discussed in class (in particular, Learning Outcomes 5 – 8).

Technical Topics

The technical topics in this class will be covered through a combination of lectures and projects. The first five weeks will focus on an overview of linear algebra and differential equations, which will provide the students with the necessary mathematical background to do the projects. Work on the projects will begin in Week 3, and will continue until the end of the quarter. A brief description of the projects is provided below.

Projects. The projects in this class are designed to introduce students to nonlinear dynamic systems and the phenomenon of chaos. The emphasis will be on simulation using Scilab, which is an open source equivalent of Matlab that can be downloaded from the following website: <http://www.scilab.org/>. Students will have two weeks to complete each project, and they can work in pairs (a single report is required for each group).

Before beginning work on the first three projects, students will be expected to go over one or more demos that cover the necessary theoretical concepts, and demonstrate how various types of simulations are performed in Scilab. The demos and the projects are related in the following way:

Prerequisites for Project 1

Demo 1: Introduction to Nonlinear Systems and a Brief Scilab Tutorial

Prerequisites for Project 2

Demo 2: Phase Plots and Attractors

Prerequisites for Project 3

Demo 3: Simulation of Discrete Systems

Demo 4: Discrete Systems with Random Elements

NON-TECHNICAL LECTURES AND READINGS

Module 1. The Limits of Scientific Knowledge

Week 1	Faith, reason and analogical thinking (Reading: Sections 1.1 and 1.2)
Week 2	Unknowable truths in science and mathematics (Reading: Section 9.1)
Week 3	Unknowable truths in science and mathematics (continued) (Reading: Section 9.1)

Module 2. Fundamental Theological Questions

Week 4	The attributes of God (Reading: Sections 9.2 – 9.3)
Week 5	Goodness, Omnipotence and Omniscience (Reading: Section 9.4)

Module 3. Controversial Issues: Miracles, Evolution and Religious Pluralism

Week 6	Miracles (Reading: Section 10.1)
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Week 7 Evolution
(Reading: Section 10.3)

Week 8 Religious pluralism
(Reading: Section 10.4)

Module 4. The True, the Good and the Beautiful

Week 9 Ethics, science and theology
(Reading: Sections 8.1 – 8.3)

Week 10 Aesthetics, science and theology
(Reading: Sections 7.1 – 7.3)

TECHNICAL LECTURES AND PROJECTS

Lectures

Topic 1 Linear differential equations and Laplace transforms

Topic 2 Linear algebra and matrices. Eigenvalues and eigenvectors

Topic 3 Linear dynamic systems and their properties.

Topic 4 Nonlinear dynamic systems. Equilibria and stability

Topic 5 Types of attractors. Fractals.

Topic 6 Formal systems and Gödel's Theorem.

Projects

Weeks 3 – 4 Project 1: Linear and Nonlinear Dynamic Systems

Weeks 5 – 6 Project 2: The Four Types of Attractors

Weeks 7 – 8 Project 3: Order, Randomness and What Lies In Between

Weeks 9 – 10 Project 4: The “Butterfly Effect” and Intermittency

GRADING

The overall grade for this class has four different components, which are weighed in the following way:

1. Projects 1 – 4	35%
2. Writing assignments 1 – 4	25%
3. Final essay	25%
4. Class participation	15%

GENERAL INFORMATION

OFFICE: Engineering Center, Room 223
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Academic Integrity Pledge:

“I am committed to being a person of integrity. I pledge, as a member of the Santa Clara University community, to abide by and uphold the standards of academic integrity contained in the Student Conduct Code.”

Disabilities Resources:

To request academic accommodations for a disability, students must be registered with Disabilities Resources, located in Benson, room 216. In order to register, please go on-line to www.scu.edu/disabilities. You will need to register and provide professional documentation of a disability prior to receiving academic accommodations. It is best to read “Required Documentation” on the website before starting the registration process in order to determine what is needed. You may contact Disabilities Resources at 408-554-4109 if you have questions.

To be in compliance with Title IX and the ADA/Section 504, a school must offer appropriate accommodation to a student whose absence is related to pregnancy or childbirth. If you are in need of an accommodation, contact the professor at the beginning of the course so that arrangement can be made. The student must also contact Disability Resources (DR) at (408) 554-4109 or www.scu.edu/disabilities to register for accommodations.

Santa Clara University upholds a zero tolerance policy for discrimination, harassment and sexual misconduct. If you (or someone you know) has experienced discrimination or harassment including sexual assault, domestic and dating violence or stalking, we encourage you to tell someone what happened promptly. For more information, please go to www.scu.edu/studentlife or contact the university's EEO and Title IX Coordinator, Belinda Guthrie at 408-554-4113 or by email at bguthrie@scu.edu. Look at: <http://www.scu.edu/affirmativeaction/compliancelinks.cfm>