## Term Information

| | |
|---|---|
| **Effective Term** | Autumn 2024 |
| ***Previous Value*** | *Spring 2014* |

## Course Change Information

**What change is being proposed? (If more than one, what changes are being proposed?)**

We propose a re-numbering of Astronomy 1142 to 2142. The revised course, Astronomy 2142, is proposed for inclusion in the Number, Nature and Mind Theme. It will also continue to satisfy the legacy Foundations course requirement, although it is not eligible for the new Foundations (which require 4 credits and a lab).

**What is the rationale for the proposed change(s)?**

Astronomy 2142 was one of the 10 initial courses submitted in the approved proposal for the Number, Nature and Mind Theme. To create Astronomy 2142, we extensively revised the prior Foundations 1142 course, and we view 2142 as a logical replacement for 1142. The proposed changes include a number of elements that require a 2000-level designation rather than a 1000-level designation. These include the requirement that the natural sciences Foundation be satisfied, readings, more in-depth problem sets, in-class discussions, a summary written essay, a variety of assessment tools, and a greater emphasis on interdisciplinary questions.

**What are the programmatic implications of the proposed change(s)?**

**(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?**

The new course will satisfy the GE Themes, but not the foundations. The precursor course was not a prerequisite for other courses, and neither is the proposed 2142 course. We therefore expect no net impact on other programs. Neither course requires a laboratory, so there is no change in required laboratory facility needs.

**Is approval of the requrest contingent upon the approval of other course or curricular program request?** No

**Is this a request to withdraw the course?** No

## General Information

| | |
|---|---|
| **Course Bulletin Listing/Subject Area** | Astronomy |
| **Fiscal Unit/Academic Org** | Astronomy - D0614 |
| **College/Academic Group** | Arts and Sciences |
| **Level/Career** | Undergraduate |
| **Course Number/Catalog** | 2142 |
| ***Previous Value*** | *1142* |
| **Course Title** | Black Holes |
| **Transcript Abbreviation** | Black Holes |
| **Course Description** | This course will tell the story of black holes: how they were conceived as theoretical ideas, how they might form from dying stars, how they were discovered, what roles they play in cosmic history, how they distort space and time, how they produce tiny but detectable gravitational wave signals, and some of the remaining mysteries they present to contemporary physics. |
| ***Previous Value*** | *The nature, formation, and discovery of black holes in the universe.* |
| **Semester Credit Hours/Units** | Fixed: 3 |

## Offering Information

| | |
|---|---|
| **Length Of Course** | 14 Week, 12 Week |
| **Flexibly Scheduled Course** | Never |

| | |
|---|---|
| **Does any section of this course have a distance education component?** | No |
| **Grading Basis** | Letter Grade |
| **Repeatable** | No |
| **Course Components** | Lecture |
| **Grade Roster Component** | Lecture |
| **Credit Available by Exam** | No |
| ***Previous Value*** | **Yes** |
| ***Previous Exam Types*** | *Departmental Exams* |
| **Admission Condition Course** | Yes |
| **Admission Condition** | Natural Science |
| **Off Campus** | Never |
| **Campus of Offering** | Columbus, Lima, Mansfield, Marion, Newark, Wooster |
| ***Previous Value*** | *Columbus, Lima* |

## Prerequisites and Exclusions

| | |
|---|---|
| **Prerequisites/Corequisites** | Prereq: Completion of the Natural Science GE Foundation and Math at the level of 1050 or higher, or permission of instructor. If taken for the GEL, Math at the level of 1050 or higher, or permission of instructor. For the GEL, students should consult with the course instructor or advisor to ensure adequate preparation for the course. |
| ***Previous Value*** | *Prereq: ACT Math Subscore of 22 or higher, or Math Placement Level R or better, or Math 1050 (075), or permission of instructor.* |
| **Exclusions** | Not open to students with credit for 1142. |
| ***Previous Value*** | Not open to students with credit for 142. |
| **Electronically Enforced** | No |

## Cross-Listings

**Cross-Listings**

## Subject/CIP Code

| | |
|---|---|
| **Subject/CIP Code** | 40.0201 |
| **Subsidy Level** | General Studies Course |
| **Intended Rank** | Freshman, Sophomore, Junior, Senior |

## Requirement/Elective Designation

General Education course:

Physical Science; Number, Nature, Mind

***Previous Value***

*General Education course:*

*Physical Science*

## Course Details

**Course goals or learning objectives/outcomes**

- The course goals and learning objectives are taken from those required for all new GE courses, as well as those specific to the Origins and Evolution Theme. Learning objectives are in the attached ELO questionnaire.Successful students will:
- General GE Goal 1: Analyze an important topic or idea at a more advanced and in-depth level than in the Foundations component.
- General GE Goal 2: Integrate approaches to the theme by making connections to out-of-classroom experiences with academic knowledge or across disciplines and/or to work they have done in previous classes and that they anticipate doing in future.
- Number, Nature and Mind GOAL 1: Analyze the nature of mathematics and/or mathematical reasoning at a more advanced and in-depth level than in the Foundations component.
- Number, Nature and Mind GOAL 2:  integrate approaches to number, nature, and mind by making connections to their own experience of mathematical thinking and its application in the world, and by making connections to prior work (abridged)
- Number, Nature and Mind GOAL 3: Successful students will experience and examine mathematics as an abstract formal system accessible to mental manipulation and/or mathematics as a tool for describing and understanding the natural world.

***Previous Value***

- *Understanding the basic principles and central facts of astrophysics, and their relation to other ideas in the physical and biological sciences.*
- *Understanding how we discovered the important principles and facts of astrophysics, thus understanding key events in the history of science both as events in human history and as case studies in the methods of science.*
- *Investigating the relationship between science and technology.*
- *Understanding the social and philosophical implications of major scientific discoveries.*

**Content Topic List**

- Black holes in theory and reality
- Gravitation: Newton and Einstein
- Black holes and time warps
- Life cycle of stars and formation of black holes
- Quasars and supermassive black holes
- Gravitational waves and the Event Horizon Telescope
- Black hole exotica

***Previous Value***

- *Black holes in theory and reality*
- *Gravitation: Newton and Einstein*
- *Black holes and time warps*
- *Life cycle of stars and formation of black holes*
- *Quasars and supermassive black holes*
- *Black hole exotica*

**Sought Concurrence**

No

## Attachments

- syllabus_a1142.pdf: Sample prior syllabus

  *(Syllabus. Owner: Pinsonneault,Marc Howard)*
- Astron2142_elo_questionnare_mar212023.docx: elo questionnare

  *(GEC Model Curriculum Compliance Stmt. Owner: Pinsonneault,Marc Howard)*
- 2142_revision_cover_mar212024.docx: cover letter

  *(Cover Letter. Owner: Pinsonneault,Marc Howard)*
- Astro2142_Syllabus_Draft_mar212024v2.docx: new proposed syllabus

  *(Syllabus. Owner: Pinsonneault,Marc Howard)*

## Comments

- Please see Subcommittee feedback email sent 10/19/2023. *(by Hilty,Michael on 10/19/2023 09:06 AM)*
- Per conversation with the department, it was determined that old materials were submitted to ASCCAS on 1/20/23. Returning the course to the department to upload the correct revised materials. RLS *(by Steele,Rachel Lea on 01/27/2023 12:47 PM)*
- Please see Panel feedback e-mail sent 10/20/22. *(by Cody,Emily Kathryn on 10/20/2022 04:04 PM)*
- This is one of four astronomy courses being transitioned from the 1000 level to the 2000 level. *(by Pinsonneault,Marc Howard on 08/30/2022 03:13 PM)*

## Workflow Information

| Status | User(s) | Date/Time | Step |
|---|---|---|---|
| Submitted | Pinsonneault,Marc Howard | 08/30/2022 03:14 PM | Submitted for Approval |
| Approved | Weinberg,David Hal | 08/30/2022 05:27 PM | Unit Approval |
| Approved | Vankeerbergen,Bernadette Chantal | 09/27/2022 01:46 PM | College Approval |
| Revision Requested | Cody,Emily Kathryn | 10/20/2022 04:04 PM | ASCCAO Approval |
| Submitted | Weinberg,David Hal | 10/21/2022 04:36 PM | Submitted for Approval |
| Approved | Weinberg,David Hal | 01/20/2023 08:26 AM | Unit Approval |
| Approved | Vankeerbergen,Bernadette Chantal | 01/20/2023 12:57 PM | College Approval |
| Revision Requested | Steele,Rachel Lea | 01/27/2023 12:47 PM | ASCCAO Approval |
| Submitted | Pinsonneault,Marc Howard | 03/23/2023 01:43 PM | Submitted for Approval |
| Approved | Weinberg,David Hal | 08/23/2023 11:58 AM | Unit Approval |
| Approved | Vankeerbergen,Bernadette Chantal | 08/23/2023 12:44 PM | College Approval |
| Revision Requested | Hilty,Michael | 10/19/2023 09:06 AM | ASCCAO Approval |
| Submitted | Pinsonneault,Marc Howard | 03/20/2024 03:10 PM | Submitted for Approval |
| Pending Approval | Weinberg,David Hal | 03/20/2024 03:10 PM | Unit Approval |

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Department of Astronomy

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March 21, 2024

To whom it may concern,

We are resubmitting Astronomy 2142 for inclusion in the Nature, Number and Mind GEN Theme. The panel had the following requests, listed below, that required attention:

- The reviewing faculty would like to see additional engagement with GEN Theme: Number, Nature, Mind Generic ELOs 1.1, 1.2, 2.1 and 2.2. For example, they are unable to see how students will engage in self-reflective learning. Additionally, they ask to see more within the syllabus about how students will engage with the idea of Number, Nature, Mind at an advanced, in-depth, and scholarly level. Overall, they would like to see greater detail within the course syllabus surrounding how the course will engage students in a critical, advanced, and scholarly study of the Theme.
- **RESPONSE: We have modified the syllabus to more explicitly make these connections. The material is now divided into broader sections, with a broad overview of the goals of each. These goals are strongly linked to the ELOs. Students will begin with classical physics, and see how its assumptions make powerful predictions about how the world works. In detail, these predictions fail; the different axioms of the theories of special and general relativity predict strikingly different behaviors under extreme conditions. Students will then see how the life cycles of stars and galaxies can actually produce black holes, and then get a window into frontier topics such as wormholes and time travel. At each stage, the student will see how mathematical reasoning can be used to make firm predictions, and how the nature of the predictions is shaped by the underlying axioms and associated world view.**
- The reviewing faculty would like to see a course calendar that showcases what students will be doing each week of the course, which should include course assignments and their deadlines, lecture/course topics, assigned readings/viewings (and their page numbers/length), and any other applicable information. Ideally, the course calendar will be broken down by class session.
- **RESPONSE: We have expanded on the discussion of the syllabus, more explicitly noting the goals of the readings and assignments and their connection to the lecture materials. We do not specify page numbers and length for the second half of the course, which deals with the discovery and properties of black holes; this is an active research field, where the particular topics to emphasize will necessarily change. We provide a breakdown of course subjects by week, not by day, as the course is taught in both 2 days / week and 3 days / week format; the same topics are covered in each week.**
- The reviewing faculty were confused regarding the prerequisites for this course and ask that they be amended to be equitable regardless of a student's General Education program. Their reasonings for asking for the prerequisites be amended are two-fold:
  - The Office of the University Registrar is unable to implement two sets of prerequisites, for two different student populations, in a single course.
  - The chosen prerequisites (Math 1050 or higher, or permission of instructor for GEL students; GEN Foundation: Natural Sciences and Math 1050 of higher, or permission of instructor for GEN students) appear to be inequitable, as they are at different levels of knowledge for the same course. Students enrolled within the course, regardless of which GE program they are operating within, should receive the same course material, instruction, assignments, and level of rigor.

  - **RESPONSE: We apologize for the confusion; we adopted the same language used in the approved 2140 and 2141 courses. We wished to permit students still taking the GEL to take this course for credit, and the alternative pathway is designed for them alone. To avoid mechanical issues, we are removing the requirement that the prerequisite be electronically enforced; we strongly recommend that students interested in taking the course to satisfy the GEL contact the instructor for permission, to ensure that they have adequate preparation for the course. Uniform requirements would, in practice, forbid students from taking the course to satisfy the GEL.**
- The reviewing faculty ask that a cover letter be submitted that details all changes made as a result of their feedback. **REPONSE: We have done so.**

Attached is a revised syllabus for Astronomy 2142, which we believe is responsive to these requests. If you have any questions, please feel free to contact me at 614-292-5346 or via email at pinsonneault.1@osu.edu.

Sincerely yours,

Marc Pinsonneault

Professor of Astronomy, The Ohio State University

# Astronomy 2142 – Black Holes
Template Syllabus

**Format**: 3 contact hours per week, lecture format with in-class participation and questions.
**GE Theme:** Number, Nature, and Mind
**Class Times & Location:**
**Final Exam:**
**Homework & Quizzes:** Specific dates. See below.
**Web Page:** http://carmen.osu.edu

**Instructor**:
Contact:
Office Hours:
**Teaching Assistant**:
Office Hours:
**Instructional Assistant**:
Office Hours:
**Astronomy Help Sessions:**
The Astronomy Department runs help sessions 4 days per week, 4:00-6:00pm. See this link.

## Course Description

Black holes are among the strangest objects ever conceived by science, with gravity so strong that it traps light and warps space and time almost beyond recognition. But black holes are more than theoretical oddities – astronomical observations provide strong evidence that they exist, and that they exist in at least two varieties. Stellar mass black holes are created in the explosive deaths of massive stars, and they can "light up" and become detectable by ingesting the outer layers of orbiting companions. Supermassive black holes, millions or even billions of times more massive than the sun, reside at the centers of galaxies and power quasars, the most luminous objects in the universe.

This course will tell the story of black holes: how they were conceived as theoretical ideas, how they might form from dying stars, how they were discovered, what roles they play in cosmic history, how they distort space and time, and some of the remaining mysteries they present to contemporary physics. Along the way we will learn about Newton's theory of gravity, Einstein's theory of space and time, the life cycle of stars, and the nature of quasars. We will also see how astronomers use observations from telescopes and satellites together with basic physical principles to demonstrate the reality of black holes.

## Prerequisites

If taken to satisfy the GEL, the only prerequisite is math at the level of Math 1050. The math in this course will not go beyond simple algebra, but there will be equations and geometrical or mathematical reasoning. The math itself will not be difficult, but the concepts will be challenging, and understanding the connection between mathematical equations and physical concepts will be one of the major things you will learn in this course. If taken to satisfy the

Number, Nature and Mind Theme, a Natural Science GEN course is a prerequisite for enrollment, or permission from the instructor. Students taking the course to satisfy the GEL should consult with their advisor and/or the course instructor to ensure that they have adequate preparation for the course materials.

## Textbook and Lecture Notes

The textbook is *Black Holes and Time Warps: Einstein's Outrageous Legacy*, by Kip Thorne. It is available from the campus bookstore and for online ordering through Amazon or other booksellers. It is also available in the Science and Engineering Library.

This is not your typical science textbook. It was written as a popular book for a broad audience, and it covers both the science of black holes and the history of black hole discoveries. It does not perfectly match to our course material, covering some topics in less detail than we will treat them and other topics in more detail. On the whole, it is a great book, written by one of the world's most creative black hole researchers. The author, Kip Thorne, shared the 2017 Nobel Prize for Physics for his pivotal role in the first detection of gravitational waves.

Required and optional reading assignments will be specified as the course progresses. Roughly 3/4 of the book will be required reading, and the homework assignments and in-class questions will draw on these readings.

The instructor will provide additional course materials through Carmen or a dedicated course web page. At the instructor's discretion these additional materials may include lecture notes and/or copies of slides shown in class, as well as links to images, videos, and other resources that are helpful in learning the course material or exploring further.

## Grading

Grades will be based on four take-home assignments (30% total), in-class questions (20% total), a take-home essay (10%), a midterm exam (15%), and a final exam (25%). The take-home assignments will consist of questions from the lectures and reading and multi-part problems for you to work out, and they should typically take 4-8 hours apiece. The essay (3-5 pages) will be assigned near the end of the course and will involve reflection on the course's central themes. The exams will be primarily multiple choice or short answer questions and may include short essays.

There will be in-class questions on most class days. The three lowest scores from the in-class questions will be dropped in computing the average score. While there is no direct attendance grade, if your attendance is poor you will inevitably do poorly on the in-class question grade, and probably on everything else as well.

Grading Scale. Grades will be assigned on the A-E scale, with A scores at 90%+, B 80-89.9%, C 70-79.9%, D 60-69.9%, and E below 60%. For A, B, and C grades, the lowest third will be marked as A-, B-, C-. For B, C and D, the upper third will be marked as B+, C+, D+.

## Course Topics & Week-By-Week Breakdown

**Note: Students will be given reading assignments to be completed prior to class, to prepare them for in-class discussions. In-class exercises will be scheduled regularly, and they will be tied to the take-home assignments.**

## Section 1: From Newton to Einstein.

Newtonian physics is an elegant description of phenomena at human scales, but its concepts of absolute space and time break down in general. In this section we will develop physical intuition for the key properties of classical physics, crucial for placing relativity in proper context. Students will discover the predictive power of classical physics, and the rising tension with the new physics of the late 19th and early 20th centuries.

**Week 1:** Introduction: Black Holes, the Universe, Time & Space Scales
Reading from textbook: Introduction and Prologue (pp.13-58).
**Week 2:** Newtonian Dynamics : Kepler, Galileo, Forces & Acceleration
**Week 3:** Newtonian Dynamics : Gravity, Orbits, Tides
Take-home Assignment #1 due.
Reading from textbook: Chapter 1 (pp. 59-86)
**Week 4:** Light & Matter: Light, Wavelength, Frequency, Energy, Spectroscopy, Atoms

## Section 2: Special Relativity.

The classical picture of an “Aether” within which light propagates is shown experimentally to break down, pointing toward new physics. The deceptively simple axioms of Einstein’s Special Relativity predict radically different behavior than classical physics as the relative velocities of observers approach the speed of light. The crucial role of the finite and constant speed of light, observer reference frames, and the underlying assumptions that we make about how to interpret the physical world, including the relativity of space, time, and simultaneity are highlighted. *The midterm will cover sections 1 and 2.*

**Week 5:** Special Relativity: Reference Frames, Luminiferous Aether, Michelson-Morley Experiment
Reading from textbook: Chapter 2 (pp. 87-120)
**Week 6:** Special Relativity: Spacetime diagrams, Time Dilation, Length Contraction, $E = mc^2$
Take-home Assignment #2 due.

## Section 3: General Relativity.

We generalize Special Relativity to accelerating observers using Einstein’s Equivalence Principle. This allows for a unification of space and time into curved spacetime. The principles of General Relativity allow us to understand gravity as the response of mass and energy to the curvature of spacetime, which itself is dictates by mass and energy: In short, matter and energy tell spacetime how to curve and the curvature of spacetime tells matter and energy how to move. General Relativity resolves previously vexing observational results and is immediately confirmed experimentally. It also predicts striking phenomena when gravitational accelerations becomes extreme, including the existence of black holes, gravitational time dilation, and gravitational light bending.

**Week 7:** General Relativity: Non-Inertial Reference Frames, Equivalence Principle, Geodesics

Midterm (in class).
Reading from textbook: Chapter 3 (pp. 121-139)

**Week 8:** General Relativity: Experimental evidence, Light Bending, Gravitational Time Dilation

## Section 4: Black Holes: From Theory to Discovery.

In this section, students will discover and understand how the known formation channels for black holes shape their expected and observed properties. Black holes require extreme conditions. In nature, these can be produced from the death of stars and in the birth and evolution of massive galaxies. Here, we trace through the life cycle of stars, how neutron stars and black holes are produced, and how we can find and study them, focusing on the experimental evidence for their existence. We also trace through the evidence for supermassive black holes lurking at the centers of galaxies, including our own Milky Way, and their relation to the galaxies around them.

**Week 9:** Origin of Black Holes: Physics of Stars, Low-Mass Stars, Fusion, White Dwarfs
Reading from textbook: Excerpts from Chapters 4, 5, 6.

**Week 10:** Origin of Black Holes: High-Mass Stars, Neutron Stars, Black Hole Formation, Accretion
Reading from textbook: Excerpts from Chapters 4, 5, 6.
Take-home Assignment #3 due.

**Week 11:** Discovery of Black Holes: Discovery, Black Hole Census, Super-Massive Black Holes
Reading from textbook: Excerpts from Chapters 7, 8, 9.

**Week 12:** Discovery of Black Holes: Quasars, Galaxies, Correlations
Reading from textbook: Excerpts from Chapters 7, 8, 9.

## Section 5: Gravity Waves, Wormholes, and Beyond.

In the final section of this course, we follow the theory of General Relativity to striking new frontier topics, discovered through mathematical reasoning. Do gravity waves exist? Can we image a black hole event horizon? Students see that with new technologies the mathematical predictions of both have been verified and that new explorations are now possible. Can black holes evaporate? Is time travel to the past possible? Can wormholes permit rapid travel across vast distances? How do we connect the structure of black holes to our knowledge of quantum mechanics? Here, students meet forefront topics, questions whose answers depend on the theory used, and questions with simply unknown answers. In this section, students will also develop their final essay, discussing how their understanding of black holes has evolved over the course of the term.

**Week 13:** Waves to Wormholes: Gravitational Waves: Production, Detection, Discovery
Take-home Assignment #4 due.
Reading from textbook: Excepts from Chapters 10, 11, 12, and 14.
Essay Assigned.
**Week 14:** Waves to Wormholes: Quantum Mechanics, Hawking Radiation, Thermodynamics
Reading from textbook: Excepts from Chapters 10, 11, 12, and 14.
**Week 15:** Waves to Wormholes: String Theory, Information Paradox, Time Travel
Reading from textbook: Excepts from Chapters 10, 11, 12, and 14.
Essay Due.
Final Exam (scheduled as per academic calendar).

## Learning Objectives

### General Education Learning Goals & Outcomes

**This course is approved as a part of the new GE Theme: Nature, Number and Mind.**

### GEN Goals

**For all themes, the goals are that successful students will:**

**1. Analyze an important topic or idea at a more advanced and in-depth level than in the Foundations component. [Note: In this context, "advanced" refers to courses that are e.g., synthetic, reply on research or cutting-edge findings, or deeply engage with the subject matter, among other possibilities.]**

**2. Integrate approaches to the theme by making connections to out-of-classroom experiences with academic knowledge or across disciplines and/or to work they have done in previous classes and that they anticipate doing in future.**

**Goals of the GEN *Number, Nature, and Mind* Theme in particular:**

1. Successful students will analyze the nature of mathematics and/or mathematical reasoning at a more advanced and in-depth level than in the Foundations component.

2. Successful students will integrate approaches to number, nature, and mind by making connections to their own experience of mathematical thinking and its application in the world, and by making connections to work they have done in previous classes and/or anticipate doing in the future.

3. Successful students will experience and examine mathematics as an abstract formal system accessible to mental manipulation and/or mathematics as a tool for describing and understanding the natural world.

**For all GEN Themes, the expected learning outcomes tied to the goals are that successful students will be able to:**

**1.1. Engage in critical and logical thinking about the topic or idea of the theme.**

**1.2. Engage in an advanced, in-depth, scholarly exploration of the topic or idea of the theme.**

**2.1. Identify, describe, and synthesize approaches or experiences as they apply to the theme.**

**2.2. Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.**

For **the GEN *Number, Nature, and Mind* Theme, the Expected Learning Outcomes tied to the goals are that** successful students are able to:

1.1 Engage in critical and logical thinking about the ideas embodied within “Number, Nature, Mind”

1.2 Engage in an advanced, in-depth, scholarly exploration of the ideas embodied by “Number, Nature, Mind”.

2.1 Identify, describe, and synthesize approaches or experiences as they apply to “Number, Nature, Mind”.

2.2 Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.

3.1 Analyze and describe how mathematics functions as an idealized system that enables logical proof and/or as a tool for describing and understanding the natural world or human cognition.

**The specific learning objectives for Astronomy 2142 (Black Holes) are:**

1. Students develop a physical understanding of Newton’s and Einstein’s theories of gravity, space, and time, the similarities and differences between them, and the senses in which Einstein’s theory has superseded Newton’s.

2. Students understand how Einstein’s theory leads to the prediction of black holes and of the properties it predicts black hole to have.

3. Students understand the interplay between gravity, pressure, and nuclear energy generation in governing the life cycle of stars, and of how and why the deaths of massive stars are expected to lead to the formation of black holes.

4. Students understand how astronomers discovered the first empirical evidence for black holes and how they have set out to demonstrate the existence of black holes as conclusively as possible.

5. Students understand why supermassive black holes are thought to be the central engines of quasars, the most luminous objects in the cosmos, and the observational methods that are used to study quasars and the dormant black holes they have left behind in the centers of galaxies.

6. Students understand the ways that advanced space missions currently under development might lead to deeper understanding of black holes, by measuring X-rays from gas falling towards the event horizon and by measuring gravity waves – propagating ripples in spacetime – produced by colliding black holes at the far edge of the universe.

**How this course meets the GEN ELOs:**

The topics at the core of Astronomy 2142 – the Newtonian revolution, special and general relativity, black holes and gravitational waves – are among *the most striking examples* of mathematics as a tool for describing and understanding the natural world, making them an ideal subject for addressing these objectives.

You will experience these striking applications of mathematics to physics – Number to Nature – throughout the lectures, readings, and homework assignments. You will learn how mathematics functions as a tool for analyzing the natural world from lectures and readings and, above all, from solving multi-part problems on homework assignments which take you from initial assumptions to sometimes surprising conclusions. The concluding essay will invite you to reflect on the role of mathematical reasoning in the theory of gravity, spacetime, and black holes and on the empirical confirmation of mathematically derived consequences of that theory. This interplay goes to the heart of the Number, Nature, and Mind theme, illustrating that human application of the abstract language of mathematics can lead to startling predictions about the natural world that can then be tested and confirmed by observations and experiments.

**This course is also approved as a part of the legacy GE Natural Science-Physical Science category.**

## Learning Objectives – GE Legacy (GEL) Course

### General Education Learning Goals & Outcomes

**Students taking the course for the Legacy GE (GEL) will have the following goals and expected learning outcomes.**

**Goals: Successful students will:**

**Understand the principles, theories, and methods of modern science, the relationship between science and technology, the implications of scientific discoveries and the potential of science and technology to address problems of the contemporary world.**

**Expected Learning Outcomes, GEL. The expected learning objective tied to the GEL goals are that students**

1. **Understand the basic facts, principles, theories and methods of modern science.**
2. **Understand key events in the development of science and recognize that science is an evolving body of knowledge.**
3. **Describe the inter-dependence of scientific and technological developments.**
4. **Recognize social and philosophical implications of scientific discoveries and understand the potential of science and technology to address problems of the contemporary world.**

**How this course meets the GEL ELOs:**

**We use the study of black holes, and more broadly the Special and General Theories of Relativity, as a worked example for the development of a modern scientific theory. This includes the development of the theory of gravity, from Galileo, Kepler, and Newton through to Einstein. The intellectual evolution of the subject is intimately**

**linked with scientific and technical discoveries, such as the ability to detect gravitational wave signatures, and we tie it to broader philosophical implications.**

### Academic Misconduct

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

## Students with Disabilities

The University strives to make all learning experiences as accessible as possible. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

### Mental Health Statement

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student’s ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life’s Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

## Religious Accommodations

Our inclusive environment allows for religious expression. Students requesting accommodations based on faith, religious or a spiritual belief system in regard to examinations, other academic requirements or absences, are required to provide the instructor with written notice of specific dates for which the student requests alternative accommodations at the earliest possible date. For more information about religious accommodations at Ohio State, visit odi.osu.edu/religious-accommodations.

## Weather Or Other Short-Term Closing

Should in-person classes be canceled, we may meet virtually via Zoom during our regularly scheduled time. All updates on course schedule will be communicated via Carmen.

Last Revised: February 2023

# New Theme Course Submission Form

## *Astronomy 2142: Black Holes*

## *Submitted for approval for the new theme Number, Nature, and Mind*

## Background Statement

Astronomy 1142, Black Holes, has been taught as a Natural Sciences GE course since 2009. Traditionally, Astronomy has numbered all of its GE classes at 1000-level and used 2000-level and above for calculus-based courses designed for astronomy & astrophysics majors. Under the revised GE, we are numbering Foundation courses at 1000-level and renumbering the Theme courses to 2000-level. These courses, including Black Holes, have always required the application of algebra and geometry to understanding the physical universe and solving astrophysics problems. Our renumbering partly acknowledges that students have always regarded these courses as challenging, and it also recognizes the higher level of presentation, discussion, and assignments that are feasible now that students will have completed the Natural Sciences Foundation requirement before taking them.

As described in detail on the syllabus, Astronomy 2142 covers several of the most revolutionary transformations in modern science: the discovery of Newton's laws of motion and gravity, the discovery that space and time and inextricably linked (Einstein's Special Relativity), the modern description of gravity as a phenomenon of curved spacetime (Einstein's General Relativity, GR), the discovery that GR predicts the existence of collapsed objects whose gravity can trap light (black holes), and the extraordinary technological advances in physics and astronomy that have enabled the empirical discovery of stellar mass black holes, supermassive black holes, and gravitational waves. The story of gravity, GR, black holes, and gravitational waves is one of the most stunning examples of the power of mathematics to explain the natural world and predict startling new phenomena, making Astronomy 2142 an ideal course for the *Number, Nature, and Mind* GE Theme.

The 3-credit hour course is comprised of class meetings involving lecture and small-group discussions, in-class questions based on those discussions, readings from the book *Black Holes and Time Warps* by Nobel Prize winning physicist Kip Thorne, homework assignments that include reflection questions based on lectures and reading and multi-part calculational problems that guide students through key topics in gravity and black holes, a concluding essay assignment in which students reflect on course themes, and a midterm and final exam that test mastery of course material. The book is a popular-level but sophisticated account of the history of relativity and black holes written by one of the field's leading scientists, and it is exceptionally good at demonstrating the often circuitous track of major scientific advances. The in-class questions and homework assignments play central roles in achieving the ELOs and assessing that achievement. Examples of the multi-part questions from the homework assignments include: using Newton's theory of gravity to explain Kepler's 3$^{rd}$ law of planetary motion and to infer the mass of Jupiter from the motion of its moons; demonstrating that chemical burning cannot account for the age of the sun but the combination of nuclear fusion and $E=mc^2$ can do so; computing the maximum luminosity and growth rate of a supermassive black hole; and using a detected gravitational wave signal to infer the masses and distance of the merging black holes that produced it. For in-class questions, students first work individually, then discuss their answers with a small group of peers before submitting them. Some of these are reflective, asking students to identify questions they have about black holes or the scientists they found most interesting or surprising in a section of the reading. Some are review, helping students synthesize recently covered material and prepare for exams. Some are advanced, guiding students to deduce $E=mc^2$ from a thought experiment based on momentum conservation, or to compute the measurable impact of a gravitational wave, the angular resolution of the global antenna network that comprises the Event Horizon Telescope, or the time required for a black hole to evaporate through Hawking radiation.

*In the remainder of this form, instructions and examples have been set in blue type while the new responses are set in black type.*

## Overview

Each category of the General Education (GE) has specific learning goals and Expected Learning outcomes that connect to the big picture goals of the program. Expected Learning Outcomes (ELOs) describe the knowledge or skills students should have by the end of the course. Courses in the GE Themes must meet the ELOs common for **all** GE Themes and those specific to the Theme, in addition to any ELOs the instructor has developed specific to that course.

The prompts below provide the goals of the GE Themes and seek information about which activities (discussions, readings, lectures, assignments) provide opportunities for students to achieve the ELO's associated with that goal. The answer should be concise and use language accessible to colleagues outside of the submitting department or discipline. The specifics of the activities matter—listing "readings" without a reference to the topic of those readings will not allow the reviewers to understand how the ELO will be met. However, the panel evaluating the fit of the course to the Theme will review this form in conjunction with the syllabus, so if readings, lecture/discussion topics, or other specifics are provided on the syllabus, it is not necessary to reiterate them within this form.

## Goals and ELOs shared by *all* Themes

**Goal 1:** Successful students will analyze an important topic or idea at a more advanced and in-depth level than the foundations. In this context, "advanced" refers to courses that are e.g., synthetic, rely on research or cutting-edge findings, or deeply engage with the subject matter, among other possibilities.

**Goal 2:** Successful students will integrate approaches to the theme by making connections to out-of-classroom experiences with academic knowledge or across disciplines and/or to work they have done in previous classes and that they anticipate doing in future.

For each of the ELOs below, please identify and explain course assignments, readings, or other activities within this course that provide opportunity for students to attain the ELO. If the specific information is listed on the syllabus, it is appropriate to point to that document. The ELOs are expected to vary in their "coverage" in terms of number of activities or emphasis within the course. Examples from successful courses are shared on the next page.

Course subject & number

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| **ELO 1.1 Engage in critical and logical thinking.** | As described in the syllabus and background statement, students will engage in logical thinking as they derive the consequences of theories of gravity and black holes by applying physical intuition and mathematical reasoning, in lectures and small-group discussions and, especially, in answering in-class questions and homework problems.<br>Students will engage in critical thinking as they reflect on the theoretical and experimental advances that led to new theories of motion, gravity, spacetime, and black holes, addressed in lectures, in small-group discussions and some in-class questions, in readings, and in reflection questions on homework assignments and the concluding essay. |
| **ELO 2.1 Identify, describe, and synthesize approaches or experiences.** | Astronomy 2142 begins with the Newtonian revolution and ends with cutting-edge discoveries of the 21st century. In understanding and describing these advances, students will build on the knowledge they have gained from the Natural Sciences foundation courses.<br><br>The story of gravity and black holes involves an extraordinary, centuries-long interplay between theoretical development and experimental or observational discoveries. Throughout the course students are challenged to identify these approaches, describe the interplay between them, and explain how the synthesis of theory and experiment leads to scientific advances. Students experience this challenge in lectures and reading, in in-class questions, and in homework assignments and exams. |
| **ELO 2.2 Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.** | At a concrete level, the development and progression of students in Astronomy 2142 is traced most clearly through the increasing sophistication of the multi-part problems in the homework assignments. For example, in the first assignment students use Newton's laws of motion and gravity, soon after they are covered in lecture, to deduce the mass of Jupiter from the orbits of its moons. In a later assignment, students apply the same ideas to calculate orbital periods around white dwarf stars, neutron stars, or black holes. After examining fusion as the energy source of the sun in the second assignment, they compare this energy to the gravitational energy released by supernova explosions and accreting supermassive black holes in subsequent assignments. In the final assignment they apply what they have learned about orbits and gravitational waves to deduce the masses and distances of merging black holes from the observed signal of the first directly detected gravitational wave.<br><br>At a more abstract level, student reflection and self-assessment occurs through in-class, homework, and exam questions. For example, at several points throughout the course students are asked "what surprised you the most?" about a particular topic, and why. The answers to this question are sometimes startlingly insightful. |

*Example responses (from Sociology 3200, Comm 2850, French 2803):*

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| ***ELO 1.1 Engage in critical and logical thinking.*** | *This course will build skills needed to engage in critical and logical thinking about immigration and immigration related policy through:*<br>• *Weekly reading response papers which require the students to synthesize and critically evaluate cutting-edge scholarship on immigration;*<br>• *Engagement in class-based discussion and debates on immigration-related topics using evidence-based logical reasoning to evaluate policy positions;*<br>• *Completion of an assignment which build skills in analyzing empirical data on immigration (Assignment #1)*<br>• *Completion 3 assignments which build skills in connecting individual experiences with broader population-based patterns (Assignments #1, #2, #3)*<br>• *Completion of 3 quizzes in which students demonstrate comprehension of the course readings and materials.* |
| ***ELO 2.1 Identify, describe, and synthesize approaches or experiences.*** | *Students engage in advanced exploration of each module topic through a combination of lectures, readings, and discussions.*<br><br>*<u>Lecture</u>*<br>*Course materials come from a variety of sources to help students engage in the relationship between media and citizenship at an advanced level. Each of the 12 modules has 3-4 lectures that contain information from both peer-reviewed and popular sources. Additionally, each module has at least one guest lecture from an expert in that topic to increase students' access to people with expertise in a variety of areas.*<br><br>*<u>Reading</u>*<br>*The textbook for this course provides background information on each topic and corresponds to the lectures. Students also take some control over their own learning by choosing at least one peer-reviewed article and at least one newspaper article from outside the class materials to read and include in their weekly discussion posts.*<br><br>*<u>Discussions</u>*<br>*Students do weekly discussions and are given flexibility in their topic choices in order to allow them to take some control over their education. They are also asked to provide information from sources they've found outside the lecture materials. In this way, they are able to explore areas of particular interest to them and practice the skills they will need to gather information about current events, analyze this information, and communicate it with others.*<br><br>*Activity Example: Civility impacts citizenship behaviors in many ways. Students are asked to choose a TED talk from a provided list (or choose another speech of their interest) and summarize and evaluate what it says about the relationship between civility and citizenship. Examples of Ted Talks on the list include Steven Petrow on the difference between being polite and being civil,* |

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| | *Chimamanda Ngozi Adichie's talk on how a single story can perpetuate stereotypes, and Claire Wardle's talk on how diversity can enhance citizenship.* |
| **ELO 2.2 Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.** | *Students will conduct research on a specific event or site in Paris not already discussed in depth in class. Students will submit a 300-word abstract of their topic and a bibliography of at least five reputable academic and mainstream sources. At the end of the semester they will submit a 5-page research paper and present their findings in a 10-minute oral and visual presentation in a small-group setting in Zoom.*<br><br>*Some examples of events and sites:*<br>– *The Paris Commune, an 1871 socialist uprising violently squelched by conservative forces*<br>– *Jazz-Age Montmartre, where a small community of African-Americans–including actress and singer Josephine Baker, who was just inducted into the French Pantheon–settled and worked after World War I.*<br>– *The Vélodrome d'hiver Roundup, 16-17 July 1942, when 13,000 Jews were rounded up by Paris police before being sent to concentration camps*<br>– *The Marais, a vibrant Paris neighborhood inhabited over the centuries by aristocrats, then Jews, then the LGBTQ+ community, among other groups.* |

## Goals and ELOs of the GE Theme: Number, Nature, and Mind

**GOAL 1:** 1. Successful students will analyze the nature of mathematics and/or mathematical reasoning at a more advanced and in-depth level than in the Foundations component.

**GOAL 2:** Successful students will integrate approaches to number, nature, and mind by making connections to their own experience of mathematical thinking and its application in the world, and by making connections to work they have done in previous classes and/or anticipate doing in the future.

**GOAL 3:** Successful students will experience and examine mathematics as an abstract formal system accessible to mental manipulation and/or mathematics as a tool for describing and understanding the natural world.

Enter your ELOs in the Table below, editing and removing rows as needed. There should be at least one ELO for each goal, and they should be numbered to correspond to the goal (e.g., ELO1.1 is the first ELO for Goal 1, ELO 2.2 would be the second ELO for the second goal).

For each ELOs, please identify and explain course assignments, readings, or other activities within this course that provide opportunity for students to attain the ELO. If the specific information is listed on the syllabus, it is appropriate to point to that document. The number of activities or emphasis within the course are expected to vary among ELOs. Examples from successful courses are shared below.

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| **ELO 1.1** Engage in critical and logical thinking about the nature and/or application of mathematical reasoning. | As described in the syllabus and background statement, students will engage in logical thinking about the application of mathematical reasoning as they derive the consequences of theories of gravity and black holes, in lectures and small-group discussions and, especially, in answering in-class questions and homework problems.<br><br>Students will engage in critical thinking about the application of mathematical reasoning as they reflect on the way that it leads to novel predictions and on the experimental tests of those predictions. These reflections arise in lecture, in small-group discussions and some in-class questions, in readings, and in reflection questions on homework assignments, and in the concluding essay (discussed further under ELO 3.1). |
| **ELO 1.2** Engage in an advanced, in-depth, scholarly exploration of the philosophical and/or cognitive foundations of mathematics and/or the application of mathematics in understanding the natural world. | The topic of black holes engages students in an advanced, in-depth, scholarly exploration of the application of mathematics in understanding the natural world. Through lectures, students encounter this application to understanding first Newtonian gravity, then special and general relativity, then the theory of stars, black holes, and gravitational waves. Through lectures, in-class questions, and, especially, the multi-part problems on homework assignments, they experience the application of mathematical reasoning to derive empirically testable consequences of theories and to interpreting observational or experimental data. They demonstrate their understanding of this process in the assignments themselves and in answers to exam questions. |
| **ELO 2.1** Identify, describe, and synthesize approaches to or experiences of the role of mathematics and mathematical reasoning in different academic and non-academic contexts. | The story of gravity and black holes involves an extraordinary, centuries-long interplay between theoretical development and experimental or observational discoveries. Throughout the course students are challenged to identify these approaches, describe the interplay between them, and explain how the synthesis of theory and experiment leads to scientific advances. Students experience this challenge in lectures and reading, in in-class questions, and in homework assignments and exams.<br><br>In all aspects of the course, students apply mathematical reasoning in the context of physics and astrophysics, from Newtonian gravity through to cutting-edge discoveries of the 21st century. To build familiarity with and intuitive understanding of physical phenomena and the equations that describe them, lectures refer frequently |

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| | to everyday experience, such as cars, playgrounds, and sports to illustrate acceleration and forces, or balloons and cooking to illustrate pressure, temperature, and thermodynamics. In homework assignments students apply mathematical reasoning to gravity and black holes; for some students, this means relearning algebraic or geometrical techniques that have become unfamiliar through disuse. Students emerge from the course with a refreshed understanding of how to apply quantitative reasoning to the everyday world, a strength that will serve them in context beyond academia. |
| **ELO 2.2** Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts. | At a concrete level, the development and progression of students in Astronomy 2142 is traced most clearly through the increasing sophistication of the multi-part problems in the homework assignments. For example, in the first assignment students use Newton's laws of motion and gravity, soon after they are covered in lecture, to deduce the mass of Jupiter from the orbits of its moons. In a later assignment, students apply the same ideas to calculate orbital periods around white dwarf stars, neutron stars, or black holes. After examining fusion as the energy source of the sun in the second assignment, they compare this energy to the gravitational energy released by supernova explosions and accreting supermassive black holes in subsequent assignments. In the final assignment they apply what they have learned about orbits and gravitational waves to deduce the masses and distances of merging black holes from the observed signal of the first directly detected gravitational wave.<br><br>At a more abstract level, student reflection and self-assessment occurs through in-class, homework, and exam questions. For example, at several points throughout the course students are asked "what surprised you the most?" about a particular topic, and why. The answers to this question are sometimes startlingly insightful. |
| **ELO 3.1** Analyze and describe how mathematics functions as an idealized system that enables logical proof and/or as a tool for describing and understanding the natural world. | The topics at the core of Astronomy 2142 – the Newtonian revolution, special and general relativity, black holes and gravitational waves – are among *the most striking examples* of mathematics as a tool for describing and understanding the natural world. (The other is the development of quantum mechanics and its application to atomic and sub-atomic phenomena.)<br><br>Students experience these striking applications of mathematics to physics – Number to Nature – throughout the lectures, small-group discussions, readings, and homework assignments. They learn how mathematics functions as a tool for analyzing the natural world from lectures and readings and most viscerally from the |

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| | experience of solving multi-part problems on homework assignments, which take them from initial assumptions to sometimes surprising conclusions.<br><br>The concluding essay invites students to reflect on the role of mathematical reasoning in the theory of gravity, spacetime, and black holes and on the empirical confirmation of mathematically derived consequences of that theory. This interplay goes to the heart of the Nature, Number, and Mind theme, illustrating that human application of the abstract language of mathematics can lead to startling predictions about the natural world that can then be tested and confirmed by observations and experiments. |

*Example responses (from History/Religious Studies 3680, Music 3364; Sociology 3200) for the "Citizenship" Theme:*

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| ***ELO 1.1 Describe and analyze a range of perspectives on what constitutes citizenship and how it differs across political, cultural, national, global, and/or historical communities.*** | *Citizenship could not be more central to a topic such as immigration/migration. As such, the course content, goals, and expected learning outcomes are all, almost by definition, engaged with a range of perspectives on local, national, and global citizenship. Throughout the class students will be required to engage with questions about what constitutes citizenship and how it differs across contexts.*<br><br>*The course content addresses citizenship questions at the global (see weeks #3 and #15 on refugees and open border debates), national (see weeks #5, 7-#14 on the U.S. case), and the local level (see week #6 on Columbus). Specific activities addressing different perspectives on citizenship include Assignment #1, where students produce a demographic profile of a U.S-based immigrant group, including a profile of their citizenship statuses using U.S.-based regulatory definitions. In addition, Assignment #3, which has students connect their family origins to broader population-level immigration patterns, necessitates a discussion of citizenship. Finally, the critical reading responses have the students engage the literature on different perspectives of citizenship and reflect on what constitutes citizenship and how it varies across communities.* |
| ***ELO 1.2 Identify, reflect on, and apply the knowledge, skills and dispositions required for intercultural competence as a global citizen.*** | *This course supports the cultivation of "intercultural competence as a global citizen" through rigorous and sustained study of multiple forms of musical-political agency worldwide, from the grass-roots to the state-sponsored. Students identify varied cultural expressions of "musical citizenship" each week, through their reading and listening assignments, and reflect on them via online and in-class discussion. It is common for us to ask probing and programmatic questions about the musical-political subjects and cultures we study. What are the possibilities and constraints of this particular version of musical citizenship? What might we carry forward in our own lives and labors as musical citizens Further, students are encouraged to apply their emergent intercultural competencies as global, musical citizens in their midterm report and final project, in which weekly course topics inform student-led research and creative projects.* |

Course subject & number

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| ***ELO 2.1 Examine, critique, and evaluate various expressions and implications of diversity, equity, inclusion, and explore a variety of lived experiences.*** | *Through the historical and contemporary case studies students examine in HIST/RS 3680, they have numerous opportunities to examine, critique, and evaluate various expressions and implications of diversity, equity, and inclusion, as well as a variety of lived experiences. The cases highlight the challenges of living in religiously diverse societies, examining a range of issues and their implications. They also consider the intersections of religious difference with other categories of difference, including race and gender. For example, during the unit on US religious freedom, students consider how incarcerated Black Americans and Native Americans have experienced questions of freedom and equality in dramatically different ways than white Protestants. In a weekly reflection post, they address this question directly. In the unit on marriage and sexuality, they consider different ways that different social groups have experienced the regulation of marriage in Israel and Malaysia in ways that do not correspond simplistically to gender (e.g. different women's groups with very different perspectives on the issues).*<br><br>*In their weekly reflection posts and other written assignments, students are invited to analyze the implications of different regulatory models for questions of diversity, equity, and inclusion. They do so not in a simplistic sense of assessing which model is "right" or "best" but in considering how different possible outcomes might shape the concrete lived experience of different social groups in different ways. The goal is not to determine which way of doing things is best, but to understand why different societies manage these questions in different ways and how their various expressions might lead to different outcomes in terms of diversity and inclusion. They also consider how the different social and demographic conditions of different societies shape their approaches (e.g. a historic Catholic majority in France committed to laicite confronting a growing Muslim minority, or how pluralism *within* Israeli Judaism led to a fragile and contested status quo arrangement). Again, these goals are met most directly through weekly reflection posts and students' final projects, including one prompt that invites students to consider Israel's status quo arrangement from the perspective of different social groups, including liberal feminists, Orthodox and Reform religious leaders, LGBTQ communities, interfaith couples, and others.* |
| ***ELO 2.2 Analyze and critique the intersection of concepts of justice, difference, citizenship, and how these interact with cultural traditions, structures of power and/or advocacy for social change.*** | *As students analyze specific case studies in HIST/RS 3680, they assess law's role in and capacity for enacting justice, managing difference, and constructing citizenship. This goal is met through lectures, course readings, discussion, and written assignments. For example, the unit on indigenous sovereignty and sacred space invites students to consider why liberal systems of law have rarely accommodated indigenous land claims and what this says about indigenous citizenship and justice. They also study examples of indigenous activism and resistance around these issues. At the conclusion of the unit, the neighborhood exploration assignment specifically asks students to take note of whether and how indigenous land claims are marked or acknowledged in the spaces they explore and what they learn from this about citizenship, difference, belonging, and power. In the unit on legal pluralism, marriage, and the law, students study the personal law systems in Israel and Malaysia. They consider the structures of power that privilege certain kinds of communities and identities and also encounter groups advocating for social change. In their final projects, students apply the insights they've gained to particular case studies. As they analyze their selected case* |

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| | *studies, they are required to discuss how the cases reveal the different ways justice, difference, and citizenship intersect and how they are shaped by cultural traditions and structures of power in particular social contexts. They present their conclusions in an oral group presentation and in an individually written final paper. Finally, in their end of semester letter to professor, they reflect on how they issues might shape their own advocacy for social change in the future.* |