

Syllabus for Astro 101 – Black Holes

Fall 2018

Instructors:

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Course Description:

This course provides an introduction to black holes, using the framework of gravitation, relativity, and quantum mechanics. Students will learn about black hole types, properties, and formation, as well as current methods for detecting black holes and modern research challenges.

Course Webpage:

Assignments, grades, and discussion forums are found on the eClass webpage for this class: <https://eclass.srv.ualberta.ca/course/view.php?id=46558>.

Lessons are available online (<https://www.coursera.org/learn/black-holes-astro-101>) throughout the course. You must create an account on Coursera using your @ualberta email address. Do not sign up for Astro 101 yet. About a week before classes start, we will email a link to a special section of the Astro 101 course. This link will also be posted on eClass. You can use this link to register in the course.

Students registered in Astro 101 should post questions about course content, logistics, and exams in the eClass forums, not in the Coursera forums. By posting in the eClass forums, you will have more direct access to help from your instructors – the Coursera forums may include tens of thousands of students, and it will not be possible for the forum moderators to address every single question. To access the eClass site, go to <https://eclass.srv.ualberta.ca/portal/> and login to the University of Alberta Credit Courses section, selecting Astro 101.

Course Objectives and Expected Learning Outcomes:

1. Describe the essential properties of black holes.

2. Explain news articles about recent black hole research using plain language and appropriate analogies.
3. Compare references of black holes in popular culture to modern physics research to distinguish science fact from science fiction.
4. Describe the application of fundamental physical concepts including gravity, special and general relativity, and quantum mechanics to reported scientific observations.
5. Recognize different types of stars and distinguish which stars can potentially become black holes.
6. Differentiate types of black holes and classify each type as observed or theoretical.
7. Characterize formation theories associated with each type of black hole.
8. Identify different ways of detecting black holes, and appropriate technologies associated with each detection method.
9. Summarize the puzzles facing black hole researchers in modern science.
10. Produce a creative work that accurately portrays black hole astrophysics (haiku, song, short story, infographic, comic strip... do not limit yourself to these suggestions.).

Prerequisites and Required Textbook: None, all course material will be available on Coursera. Supplemental material may be posted on eClass.

Optional Learning Resources:

<https://www.youtube.com/channel/UCh9ca3YbpxueTxkT7BIH4cw>

<https://twitter.com/AstroBlackHoles>

Marking Scheme:

Knowledge check exercises:	10%
Black hole investigation:	5%
Creative work:	5%
Midterm exam:	40%
Final exam:	40%

Grades:

Grade will be automatically computed according to the scheme above, and will be viewable on eClass.

Late policy:

Late assignments will not be accepted. Submissions must be made online via eClass, which requires internet access. If you have difficulty accessing or using eClass, please contact University of Alberta Information Technology services at: ist.ualberta.ca.

Midterm and final exams:

Each exam is multiple choice and two hours. Students are responsible for booking their exams by contacting the Learning Assessment Center at lac.ualberta.ca to book their exam. Midterms may be booked for Oct 22-26 and finals may be booked for Dec 17-21. No aids (formula sheet, cell phone, calculator, etc.) are permitted. No questions will require calculators. Please book early, since slots fill quickly.

In order to book your exams:

1. Go to <http://lac.ualberta.ca/students#book>
2. Login using your UofA account.
3. The dates for the exam will appear under: Astro101 Fall 2018 Midterm/Final
4. Select the date. A new small window will appear under the date and you will be able to select the time to begin the exam. Remember you will have 2 hours to complete the exam.
5. Register.

If you have any problems registering or need to change your exam date, please contact the Learning Assessment Center as soon as possible at:

780-492-3563

edlac@ualberta.ca

Both midterm and final exams will be in a multiple choice format and performed on a computer at the Learning Assessment Center at the University of Alberta (North Campus). Address: Education North 3-106, University of Alberta, 11210 - 87 Ave Edmonton, AB, T6G 2G5.

Representative evaluative course material is found in the quizzes for each Module posted on Coursera. These are not for marks, and may be attempted multiple times. Please use these to test your knowledge of the material and your level of preparation for the midterm and final exams.

Missed Midterm Exams and Assignments:

Due to the ability to choose the midterm date and time, a deferral will not normally be granted. However, a student who cannot write a term examination due to incapacitating illness, severe domestic affliction or other compelling reasons can apply for a deferred midterm examination. Deferral of term work is a privilege and not a right. In all cases, instructors may request adequate documentation to substantiate the reason for the absence at their discretion. There is no guarantee that a deferral will be granted. Misrepresentation of facts to gain a deferral is a serious breach of the Code of Student Behaviour.

Deferred Final Examination:

A student who cannot write the final examination (December 17-21, 2018) due to incapacitating illness, severe domestic affliction or other compelling reasons can apply to write a deferred final examination. It is important that you contact the Professor of this course as soon as possible, to see if an application for deferral is possible. Such an application must then be made to the student's Faculty office within 48 hours of the missed examination and must be supported by a Statutory Declaration or other appropriate documentation (Calendar section 23.5.6). Deferred examinations are a privilege and not a right. There is no guarantee that a deferral will be granted. Misrepresentation of facts to gain a deferral is a serious breach of the Code of Student Behaviour.

University and Faculty Policies:

Academic Integrity: The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at www.governance.ualberta.ca) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All forms of dishonesty are unacceptable at the University. Any offence will be reported to the Associate Dean of Science who will determine the disciplinary action to be taken. Cheating, plagiarism and misrepresentation of facts are serious offences. Anyone who engages in these practices will receive at minimum a grade of zero for the exam or paper in question and no opportunity will be given to

replace the grade or redistribute the weights. As well, in the Faculty of Science the sanction for cheating on any examination will include a disciplinary failing grade (NO EXCEPTIONS) and senior students should expect a period of suspension or expulsion from the University of Alberta.

Exams: Your student photo I.D. is required at exams to verify your identity. Students will not be allowed to begin an examination after it has been in progress for 30 minutes. Students must remain in the exam room until at least 30 minutes has elapsed.

Cell phones are not to be brought to exams.

Accessibility-Related Accommodations: Eligible students have both rights and responsibilities with regard to accessibility-related accommodations. Consequently, scheduling exam accommodations in accordance with SAS deadlines and procedures is essential. Please note adherence to procedures and deadlines is required for U of A to provide accommodations.

Contact SAS (www.ssds.ualberta.ca) for further information.

Student Success Centre: Students who require additional help in developing strategies for better time management, study skills or examination skills should contact the Student Success Centre (2-300 Students' Union Building).

Disclaimer: Any typographical errors in this Course Outline are subject to change and will be announced in class.

Policy about course outlines can be found in [§23.4\(2\)](#) of the University Calendar.

Course Schedule and Assignment Information

(see eClass for digital version)

Date	Item
Sept 4	Classes Begin
Sept 4-14	Module 1: Introduction to Black Holes
Sept 10	Midterm exam booking opens
Sept 17	Last day to register for Astro 101
Sept 17-21	Module 2: Life and Death of a Star
Sept 21	Deadline: Knowledge Check #1 (covers Modules 1-2)
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Sept 24-28	Module 3: The Structure of Spacetime
Oct 1-5	Module 4: Sizing Up Black Holes
Oct 5	Deadline: Knowledge Check #2 (covers Modules 3-4)
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Oct 8-12	Module 5: Approaching a Black Hole
Oct 15-19	Module 6: Crossing the Event Horizon
Oct 19	Deadline: Knowledge Check #3 (covers Modules 5-6)
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Oct 22-26	Midterm exam week
Oct 29	Final exam booking opens
Oct 29-Nov 2	Module 7: Inside a Black Hole
Nov 2	Creative work proposal due
Nov 5-9	Module 8: Hunting for Black Holes
Nov 9	Creative work peer feedback due
Nov 9	Deadline: Knowledge Check #4 (covers Modules 7-8)
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Nov 13-16	Fall reading week: enjoy your break!
Nov 19-23	Module 9: Our Eyes in the Skies
Nov 23	Creative work draft due
Nov 26-30	Module 10: Riding the Gravity Wave
Nov 30	Creative work draft feedback returned by instructors
Nov 30	Deadline: Knowledge Check #5 (covers Modules 9-10)
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Dec 7	Deadline: Black hole investigation

Dec 7	Deadline: Creative work final copy
Dec 17-21	Final exam week

Knowledge Check exercises (10%):

Five exercises will be assigned during the semester, each worth 2%. They will test vocabulary and key principles covered over two course modules. Knowledge Checks will be available on eClass. Each Knowledge Check closes at the end of the second module it covers. Knowledge Checks are graded for completion, and may be retaken multiple times.

Knowledge checks have two purposes: 1) provide incentive for you to keep up-to-date with coursework, and 2) provide tools for you to evaluate your understanding of the material.

Black hole investigation (5%):

This is a wiki-style description of a black hole. You will select a black hole to learn about, and answer some key questions in short-answer or paragraph form. This write-up must be submitted on eClass, and is due by Dec 7th.

The purpose of this is to give you credit for recognizing and differentiating black holes, their formation mechanisms, and the methods used to detect them.

You will find and submit answers to the following (each enumeration worth 1%):

- 1) What is the black hole's name, and what sources have you used?
- 2) What is its mass and subsequent classification?
- 3) What evidence supports the existence of this black hole? How has it been observed? What telescopes were used?
- 4) What is the black hole's environment (binary system, galactic nucleus, etc)? What evidence is there for a jet, accretion disk, or corona?
- 5) Describe a property of this black hole that is interesting to you, and not covered above. This need not be unique to your black hole, but must not be true of all black holes of its type.

Possible sources of information on the black holes will be posted on eClass during the semester.

Creative item (5%):

This is a haiku, song, poem, short story, infographic, comic, or other creative work that centres on black holes or their properties. This must be submitted on eClass. There are four components to this grade.

- 1) Post a proposal for your creative work on the eClass forums by Nov 2. The purpose is to encourage you to start early. This is worth 1%, awarded for completion.
- 2) Reply to someone else's post, giving constructive feedback, by Nov 9. Feedback must be respectful, outline one strength of their draft, and suggest an improvement. The purpose is to foster discussion and help students who need ideas. This is worth 0.5%, awarded for completion.
- 3) Submit your creative work on eClass for instructor feedback before Nov 23. The instructor will give feedback before Nov 30. The purpose is to give you preliminary feedback, allowing you to work on your project more. This is worth 0.5%, awarded for completion.
- 4) Submit your creative work on eClass before Dec 7. This is worth 3% and will be evaluated according to a rubric posted on eClass.