

Astronomy 5682 Review Guide for Final Exam

The final exam will be Monday, May 1, 4-5:45 pm, in our usual classroom. You may bring the page of handwritten notes that you brought to the midterm and an *additional* page (both sides) of handwritten notes, and a calculator that is not a cell phone.

Joy Bhattacharya will hold a review session on Wednesday, 4/26, 4-5:30 pm in McPherson Lab 1040. This review session will focus on the solutions to the problem sets and in-class questions, though you are welcome to bring other questions as well.

I will hold a review session on Friday, 4/28, 4-5:30 pm in McPherson Lab 1040. This review session will be Q&A on any topics covered in the course, so it is most useful if you have done at least some of your review and identified where you have questions.

We will make and post zoom recordings of both review sessions for those who cannot attend in person.

The exam will focus on material that has come up in the second half of the course, beginning with §5 of the course notes. However, this material builds on the first part of the course, and in that sense the final is necessarily “cumulative.” You should certainly be familiar with the FRW metric, the Friedmann equation, and their uses. You should also re-read §1 of the course notes carefully — this time through, you should have a good understanding of what everything means.

Two important themes of the final exam will be: (a) the history of the universe, and (b) the empirical basis of the standard big bang model and the “ Λ CDM” model. On the first theme, you should pay particular attention to the physics of big bang nucleosynthesis, the cosmic microwave background, the transition from a radiation-dominated universe to a matter-dominated universe to a Λ -dominated universe, and the inflation epoch.

On the second theme, pay particular attention to how big bang nucleosynthesis and the CMB provide evidence for a hot early universe with the expansion rate predicted by the Friedmann equation, to how we use standard candles (Cepheids, supernovae) and standard rulers (BAO) to measure the expansion rate and expansion history of the universe, to the information encoded in cosmic microwave background anisotropy, and to empirical evidence for dark matter, dark energy, and flat geometry.

The most useful things to review are the lecture notes, the in-class questions, and the solutions to *all six* of the problem sets. Make sure you understand my solution sets, regardless of how you did on the assignment. If you did the optional recovery problem set, it will also be useful in preparing you for the final exam, and you may want to take a look at this problem set even if you didn’t decide to do it. I also strongly recommend looking at the online lecture notes in addition to your own notes from class.

When writing down equations for your notes, pay attention to the *physical interpretation* of each equation: what principles does it represent, what are the quantities that enter, what are their units, and how can the equation be used? Remember to include the “useful form” of the Friedmann equation from §5, p. 4, and the formula for the comoving distance from §6, p. 2.

The exam will include a mix of qualitative questions and problems to solve, roughly like the midterm.

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Student Evaluation: A5682, Spring 2023

I will provide a few minutes on the last day of class for you to fill out the checklist portion of the online SEI. If you are not present for the last day of class, please fill it out. However, for narrative comments, I strongly prefer that you use *this* freeform evaluation for narrative comments rather than submit them via SEI.

Please set aside 20 minutes during your review for the final to write this evaluation, and bring it with you to the final. Ideally you should do this towards the end of your review, since that will already have given you a chance to reflect on the course. *Writing the evaluation can itself be a helpful part of your review.*

I will have an envelope at the final so that you can turn in your evaluations anonymously. *Please do not write your name on your evaluation.* If you don't bring the evaluation to the final, I will ask you to complete it as soon as you are done with the exam so that I collect them all by the end.

Tell me anything you would like to tell me about the course. I am interested in knowing what aspects of the lectures, class questions, assignments, notes, and readings you found most useful and/or problematic. You could also comment on what aspects of the material you found most useful or interesting, what material you think we spent too much time on, and what material you think we should have spent more time on (or should have covered but didn't). I welcome any suggestions you have for ways that I could improve the course the next time I teach it.

You are welcome to type your evaluation to help keep it strictly anonymous. I recommend using a separate sheet so that you have adequate room for your comments. I will not read any evaluations until I have assigned course grades.