Course Syllabus

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AST 4100: Astronomical Techniques – Winter 2020

Lecture: Monday, Wednesday, Friday, 9:30am – 10:20am
Location: Education Building, Rm 0049
Professor: Edward Cackett
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Phone: (313) 577 9355
Office hours: Wednesday 10:30am – 11:30am. If you can't make it during regular office hours, please feel free to email me to schedule an appointment at some other day/time. As a general rule, if my office door is open, you're free to come in and ask questions.

Course synopsis
This is a 3-credit course which covers techniques used in modern astrophysics. We will discuss how astronomers make quantitative observations the universe. The course will cover detectors, telescopes and techniques for multiwavelength astronomy across the electromagnetic spectrum from radio waves through to gamma-rays. Note that AST 4200 is a separate, associated lab class that goes along with this lecture class.

Learning Outcomes
By the end of the course students should be able to do the following:

1. Understand how astronomers can observe the universe
2. Know the basic designs of optical telescopes
3. Understand how the atmosphere affects ground-based observations, and how adaptive optics can correct atmospheric effects
4. Know how detectors used in optical astronomy work, and their pros and cons
5. Understand how CCD observations are calibrated
6. Know how the following techniques work: photometry, astrometry, polarimetry, spectroscopy and interferometry
7. Understand how astronomers observe across the whole electromagnetic spectrum, including radio, X-ray, gamma-ray, and cosmic-ray astronomy
8. Be familiar with the detection of gravitational waves

Text
The majority of the material for this class will come from:

Observational Astronomy (2nd Edition) by D. Scott Birney, Guillermo Gonzalez and David Oesper (Cambridge University Press).

Hence, this textbook is recommended for this class. However, there are several topics not sufficiently covered in this textbook and I will be using resources from elsewhere. The lecture notes provided in class will be sufficient for those topics.

If you are an astronomy major or minor I would highly recommend getting:
An Introduction to Modern Astrophysics (2nd Edition) by Carroll & Ostlie (Cambridge University Press). This is a (very) large textbook covering the entirety of astrophysics. It is an extremely useful reference for all of astrophysics. It covers much of the material in this course in several of the early chapters. It is also covers material for the Stellar Astrophysics (AST 5010) class, and Galaxies & the Universe (AST 5100). Therefore, while not required for this class, it will be an excellent additional reference and will be useful for the later astronomy classes.

Canvas
Course announcements, grades, etc will be made using the Canvas system (canvas.wayne.edu). Please make sure you check it regularly.

Exams

- There will be 2 mid-term exams and 1 final exam. Each will be worth the same percentage of the final grade. The final is not cumulative.
- As per the university's exam schedule, the final exam will be held on **Monday, April 27 from 8:00 am - 10:00 am (note the different time).**
- Material covered on each exam will be announced in class, and through Canvas and is given in the syllabus class schedule.
- There will be no make-up exams.
- If you do not take the final exam, your course final grade will be automatically 'F' – no exception.
- If you miss more than one mid-term, your course final grade will automatically be 'F' – no exception.

Homework
There will be 10 sets of homework problems. Due dates for homework sets are noted in the class schedule at the end of the syllabus. Note that each homework set will be worth 4% of the overall grade. Missing two homework set is equivalent to dropping your grade by more than one increment (i.e. going from A- to B+). I therefore highly recommend putting in the time and effort required to do well in the homework. Experience also shows that those who put effort into the homework tend to do better overall.

Performance Evaluation

Your final grade in this course will be based on the following items:

Exams: 60% (20% for each midterm and 20% for the final)
Homework: 40%

Final Grades

Final grades will be given using the grading scale in the table below, however, it is almost impossible to set 'perfect' exams, and so grades may be curved, if necessary

A	85 - 100
A-	80 - 84
B+	75 - 79
B	70 - 74
B-	65 - 69
C+	60 - 64
C	55 - 59
C-	50 - 54
D+	45 - 49
D	40 - 44
D-	35 - 39
F	< 35

Advice

1. Get the text, read it before class, go to class, take notes and participate in the discussion.
2. **Come to class!** Research has shown that students who come to class do better, on average, than those that don't.
3. **Ask questions in class.** If things aren't clear, or even if you just want me to leave something up for longer to write it down, **don't be afraid to ask**. You will likely not be the only one with the same question/request.
4. **Do the homework!** The homework counts for 40% of the final grade. Skipping homeworks, or not putting enough time into your homework will significantly affect your grade.
5. You cannot skip the final exam because you feel you are getting a good enough grade without it. If you miss the final exam you will receive a grade of 'F'. No exceptions.

In-class policies

Out of consideration for the other students in the lecture please abide by the following rules of conduct:

1. Turn off all cell phones while in lecture

2. Please arrive on time for lecture and do not leave early
3. Please be mindful of your classmates

Student e-mails

I am happy to answer questions via e-mail. However, please be sure to look for announcements on Canvas and check this syllabus before emailing me with questions. Please also follow proper professional etiquette in your emails. For instance it is appropriate to use full sentences with proper grammar and punctuation (i.e. no 'text' slang, please). Rude or improper emails will not be answered.

E-mails will generally only be answered ***Monday – Friday, 9am – 5pm***. **Do not expect emails to be answered during the evening or on the weekend.**

Academic dishonesty

Information about what is considered academic misconduct is provided on the Dean of Students Office website: **https://doso.wayne.edu/conduct/academic-misconduct (https://doso.wayne.edu/conduct/academic-misconduct)**

All of the graded assignments are designed to measure your individual understanding of the material. No forms of cheating on these graded assignments will be tolerated (working together on the homework assignments is not considered cheating but copying of someone else's homework is). Anyone found cheating on any graded activity will receive a grade of zero for that part of their grade, and may receive a failing grade for the course.

Student Disabilities Services

If you have a documented disability that requires accommodations, you will need to register with Student Disability Services (SDS) for coordination of your academic accommodations. The SDS office is located in the Adamany Undergraduate Library. The SDS telephone number is 313-577-1851 or 313-577- 3365 (TTD only). Once you have your accommodations in place, I will be glad to meet with you privately during my office hours or at another agreed upon time to discuss your needs.

Course Drops and Withdrawals

In the first two weeks of the (full) term, students can drop this class and receive 100% tuition and course fee cancellation. After the end of the second week, there is no tuition or fee cancellation. Students who wish to withdraw from the class can initiate a withdrawal request in Academica. You will receive a transcript notation of WP (passing), WF (failing), or WN (no graded work) at the time of withdrawal. No withdrawals can be initiated after the end of the tenth week. Students enrolled in the 10th week and beyond will receive a grade. Because withdrawing from courses may have negative academic and financial consequences, students considering course withdrawal should make sure they fully understand all the consequences before taking

this step. More information on this can be found at: **https://wayne.edu/students/register/dropping (https://wayne.edu/students/register/dropping)**

Course Schedule

This is the expected schedule for the course, though it is subject to change as needed. We lost 3 classes to snow storms/cold weather last Winter - this is made worse by the 9:30am start time. I have therefore built in a number of 'flex classes' that can be moved around as needed. Please check Canvas regularly for announcements and schedule updates.

Day	Date	Lecture Topics	Chapter	Homework Due
M	1/6/20	Intro, Astrophysical Information		
W	1/8/20	The celestial sphere, and coordinate systems	1	
F	1/10/20	Time	2	
M	1/13/20	Changes in coordinates	4	
W	1/15/20	Quantifying Light	5	HW 1 (Chp 1, 2, 4)
F	1/17/20	Flex Class		
M	1/20/20	No Class (MLK Day)		
W	1/22/20	Telescopes 1	6	HW 2 (Chp 5)
F	1/24/20	Telescopes 2	6	
M	1/27/20	Effects of the atmosphere	7	
W	1/29/20	Photoelectric effect, Detectors	8	HW 3 (Chp 6, 7)
F	1/31/20	Flex Class		
M	2/3/20	CCDs & Calibration	9	
W	2/5/20	Review for Exam 1		HW 4 (Chp 8,9)
F	2/7/20	**Exam 1**		
M	2/10/20	Flex Class		
W	2/12/20	Photometry	10	
F	2/14/20	Photometry	10	

M	2/17/20	Astrometry	11	
W	2/19/20	Polarimetry		HW 5 (Chp 10)
F	2/21/20	Flex Class		
M	2/24/20	Emission & Absorption Lines		
W	2/26/20	Astronomical Spectrographs	12	HW 6 (Chp 11, Polarimetry)
F	2/28/20	Spectroscopy	13	
M	3/2/20	Adaptive Optics		
W	2/4/20	Adaptive Optics		HW 7 (Chp12, 13)
F	3/6/20	Deconvolution & High contrast imaging		
M	3/9/20	**No Class - Spring Break**		
W	3/11/20	**No Class - Spring Break**		
F	3/13/20	**No Class - Spring Break**		
M	3/16/20	Review for Exam 2		HW 8 (Adaptive Optics)
W	3/18/20	**Exam 2**		
F	3/20/20	Intro to Radio Astronomy		
M	3/23/20	Radio antennae & receivers		
W	3/25/20	Radio interferometry		
F	3/27/20	Flex Class		
M	3/30/20	Aperture Synthesis (radio imaging)		
W	4/1/20	Optical interferometry		
F	4/3/20	X-ray Astronomy		HW 9 (Radio Astronomy & Interferometry)
M	4/6/20	X-ray Astronomy		

W	4/8/20	Gamma-ray Astronomy		
F	4/10/20	Cosmic-ray Astronomy		
M	4/13/20	Neutrino Astronomy		
W	4/15/20	Gravitational Wave Astronomy		
F	4/17/20	Gravitational Wave Astronomy		HW 10 (X-ray, Gamma-ray, Cosmic-ray and neutrino astronomy)
M	4/20/20	Review for Exam 3		
M	4/27/20 **(8 AM)**	**Exam 3**		

Course Summary:

Date	Details