ASTR 19 Galaxies and the Universe

Course Syllabus

Dr. Melinda L. Weil
CRN: All Sections

Hello and Welcome Online Students!

Our ASTR 19 class focuses on understanding the galaxies full of stars, gas and dust to learn about our entire Universe of space and time, mass and energy. We explore our existence at the largest levels. Where are we and how did we get here?!?

This syllabus is really long and contains a lot of sometimes dull info. But it is important because most of the information about how our class runs is in here.

I'll ask Quiz questions on the syllabus in Week 2, so you'll get some credit for reading it!

Course Description

Introduction to cosmology, galactic and extragalactic astronomy, with a focus on basic questions of existence: Where do we come from and what is our fate? Covers the universe's origin, evolution, fate, expansion and acceleration, cosmological models explaining these, large scale structure, dark matter and dark energy, properties and phenomena of galaxies, including the Milky Way and active galactic nuclei. UC/CSU*

* ASTR 19 fulfills your Physical Science/Natural Science requirement. The credit transfers to all universities in both the University of California and California State University systems. It transfers to most other universities as an introductory physical science course too.

Link to Course Outline of Record

Student Learning Outcomes

After successful completion of this course, students will be able to:

- Differentiate the properties of the universe, large-scale structure, and galaxies, and of fundamental particles and forces.
- Discuss the history of cosmology from the ancient to modern world.
- Interpret the structure, origin, evolution of the universe and its large-scale structure from the perspective of physical cosmology.
- Compare the types of galaxies, and their structure, formation, evolution, and interactions.
- Describe major astrophysical phenomena at the galaxy and universe scales that remain unresolved.

Class Meetings

None, ASTR 19 is fully asynchronous, which means we have no class meetings.

Suggested Textbooks

A textbook is not required but recommended. You know yourself better than I do, as to whether you are able to pass our class without a textbook to assist you. If you are not sure, try the first few weeks without one, then decide.

The suggested book is “Universe: Stars and Galaxies” by Freedman, Geller, & Kaufmann, 5th or 6th edition, published by Macmillan. (The 4th edition has the chapters set up differently but is still pretty good if you can't find the later editions.) The textbook may be bought used or rented; the 6th edition is available at at https://store.macmillanlearning.com/us/product/Universe-Stars-and-Galaxies/p/1319115098 (Links to an external site.)

"Universe: Stars and Galaxies" is the text I used to develop the class so the order of the chapters and topics and the figures are based on it. Most relatively recent, cheap used textbooks on introductory astronomy could help you. You may also opt for the Open Stax free astronomy textbook (Links to. FOr. For these options, the chapters, order of the topics, and figures are likely to be different so they will be harder to use. I personally would choose an older, used edition of "Universe: Stars and Galaxies" if I wanted to make learning in the class easy and save a little money. Also, the full text called "Universe" by the same authors may be available for cheap - the 9th, 10th, and 11th editions of that one work.

CCSF offers the Associated Students Book Loan program if you need help paying for textbooks. Depending on need and the number of units you are taking, they will give you Book Vouchers (coupons) to be used at the CCSF Bookstore.

Is this a hard class?

I don't think so. Whether this is your first online class or you have passed online classes before, remember that one important action you take for success is budgeting enough time! You will want to study the lessons and complete assignments each week. Online classes require the same amount of time as face-to-face classes. You will find a Time Management Suggestions document on our class Canvas website to assist you. I will clearly indicate deadlines for completing assignments, including taking quizzes and participating in online discussions, when each weekly module opens. Due dates are always on Thursdays and Sundays at 9pm. I drop your lowest two discussions and lowest two quizzes of the semester.

Course Communication

Instructor Contact

	Dr. Melinda L. Weil, Ph.D. Astronomy Department City College of San Francisco 50 Frida Kahlo Way, S29 San Francisco, CA 94112	

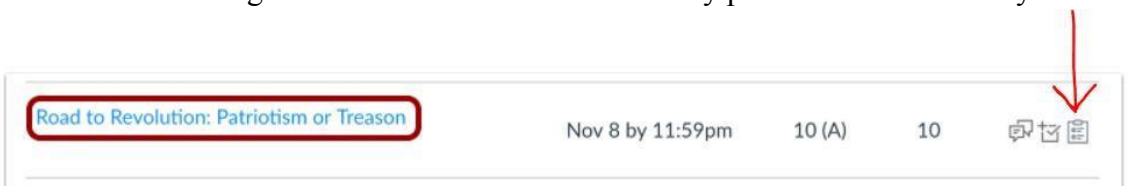
Email: Sending me an Inbox message within Canvas is best. I will respond to all course email within 48 hours Monday-Friday, exclusive of school holidays. If you don't hear from me during that time, assume your email did not make it to me and try again, please. If there are problems with Canvas, you can email me at mweil@ccsf.edu

Instructor Website (if you want to know a bit more about me):

Tel: 415-239-3242 (available during office hours when college is open for classes again)

Communication Plan

- I will often contact you through the Canvas Learning Management System email. The Inbox is in the far left-hand Canvas menu. Again, this is also the best way to reach me, as I check my email all the time when I am working.
- I will also post announcements on the Instructor Announcements page in Canvas throughout the semester. Canvas notifies students according to their preferred Notification Preferences (Links to an external site.)Links to an external site.as soon as the instructor creates an Announcement.
- In the left-hand Canvas menu (on most pages) is Pronto. (It has the call-out symbol with 3 horizontal dots in it. Can you see it?) It is another way to communicate with me quickly if I am on Canvas. Pronto can be used as a group or individual chat in our class. It instantly connects each user with the students and instructors in their current courses by automatically creating a group chat for each section the user is in. You are welcome to use Pronto to reach me or to send a message about astronomy that may be of interest to other students.The first time you open Pronto, you will need to complete a few steps.
- Office Hours: You may view the video conferencing office hours in the Calendar on the left-hand Canvas menu. There are thirty-minute appointment slots every Tuesday and Thursday between 11:30am and 12:30pm. (But if the weekly office hours don't fit your schedule, no problem! Just email me for an appointment time that works for you.)
  Reserve your appointment slot at least 24 hours in advance, please, so I can prepare for you.
  1. Click on the Course Calendar.
  2. Click on Find Appointments. Look for our class.
  3. Locate available appointments on the Calendar.
  4. Click Reserve and remember to use the Zoom link in the Appointment details to join office hours when the time comes.
- Office: Science Hall 405. For in person classes only. The Astronomy Department offices are located at the top of the central staircase. They are not accessible; please ask if you need to meet in an accessible room.
- Important: After I have graded your weekly Discussion, visit your Grades page and click on the Rubric icon at the right side for the Discussion to see my personal comments to you.



- Your weekly quizzes also contain feedback for your own self-assessment.

Building Community

Most weekly Discussions will ask that you interact with one another through Peer Review. Instructions will be in each Discussion and will allow students to support one another while also earning credit for those communications. In addition to my individual comments on your Discussion posts, you'll receive insight from other students, and I hope we will learn from each other.

Also, I encourage you to use Pronto to discuss topics of interest or ask questions of other students. Access to Pronto is through the call-out symbol with three dots on the left-hand Canvas menu. You can talk with one another about setting up study groups or share interesting astronomy information you have found - music, images, news reports. Please use "Netiquette" with only respectful and supportive language.

Help, I have Internet problems!

The college has a couple of places you can look for help.
Low Cost and Free Internet Resources
San Francisco Free Wifi
Students who are in need of food and other items to live comfortably have options available through the college and city. In addition, there is the Facebook group called Buy Nothing (San Francisco) where many free items are posted every day.

Course Structure

Canvas

We use the **Canvas Learning Management System.** Students will use Canvas Learning Management System for reading content material, assignment instructions, submitting assignments, viewing classmates' work, sharing resources, and viewing grades. Access Canvas by going to the CCSF Website at http://www.ccsf.edu (Links to an external site.) and click on “CANVAS” at the top of the page. Enter our ASTR 19: Galaxies and the Universe class.

If you have problems with Canvas, there is 24/7 assistance. It is available on the left-hand Canvas menu under "Help" at the “?” icon.

Where to go and What to do!

Our class uses a weekly Module structure. The best way to begin every time you enter is to check the Home page to see whether you have any Announcements to view or Peer Reviews to complete, then click on **Modules** in the left-hand course menu on the left. If Modules is not visible, click on the three bars icon in the upper left corner to expand the Course Navigation menu. As long as you follow each weekly module, the only other menu links you need often are this Syllabus, Grades, Announcements and maybe Zoom. "See" you soon!

In online courses, your regular participation is the equivalent of coming to a class held on campus. Participation involves logging in to our course, navigating through the sections in a module, studying the Content Slides that contain the main lesson, then completing assignments -- mainly discussions and quizzes, and your two exams. Your participation is not only an important part of your learning and the way to earn points towards the grade you want, you will also be able to contribute to the learning of your peers. (Again, check out the Time Management Suggestions in the Week 1 resources... that could help you achieve your goal!)

Module Structure

There is a new module each week of the semester, mostly with an Overview, Content Slides, Videos, Review, Assignments, and a short Summary, the same every week. Each week's module opens on Saturday mornings by 3am so people can get started early. The Content Slides are the main material for each week. This knowledge is what the Discussions and Quizzes will assess. Remember, you can see the title of each slide when you look at the Slide Numbers so you can always find specific information you want to reread or review.

Required Software

Canvas runs on many platforms, but it is known to work best with the Firefox, Microsoft Edge, and Chrome browsers. It also has a few known problems on phones and tablets, with Peer Review and a few other aspects.

- Update your browser (Links to an external site.) Links to an external site.
- Adobe Reader (Links to an external site.)Links to an external site.

Grading

Discussions and Quizzes

Most weeks will have two assignments due, one discussion that will usually have two parts including a peer review and one quiz. (A few of our 16 weeks have only one assignment.) View the discussion rubrics before you begin each discussion to see how they are graded. View the rubric in Grades again after you complete each discussion for a personal message from me. Each assignment is worth 100 points.

Your lowest discussion will be dropped and the rest are worth 40% of your total grade. Your lowest two quizzes will be dropped and the rest are worth 30% of your total grade. The Canvas software at “Grade” in the left-hand course menu keeps track of these grades every week, so you always know where you stand in our class so far. Remember to check the discussion rubric there!

Exams

There is one midterm exam in Week 8 or 9, and one final exam during finals week. The exams are each worth 15% of your grade for a total of 30%. The material comes mainly from the PowerPoint Content Slide lectures.

There are study guides for your midterm and final in the Study Guides section at the end of the Syllabus. Use them and the Key Ideas Reviews to help focus your attention on important topics. It should help to refer to them throughout the class, not just when you get towards exam time!

IMPORTANT: For exams, you may use paper notes or a paper textbook to help you. But you cannot leave the test page otherwise the exam is invalidated and earns zero points! You cannot go to another tab or window or jump to another application on your computer.

Unless you have a documented excuse, if any exam is missed then a zero will be recorded as the score.

Grading Policy

Visit “Grades” in Canvas to keep track of your grades. I post grades and individual comments to you which you can view on the online Canvas gradebook.

How do I view my grades, teacher comments, and an assignment rubric as a student?

Grading scale	
Letter Grade	**Percent**
A	≥ 90%
B	≥ 80 to 89%
C	≥ 69 to 79%
D	≥ 58 to 68%
F or FW	<58%

An “F” grade indicates that a student attended, participated and completed the course but failed to master the course curriculum.

An “FW” grade indicates the student stopped attending a course after the “last day to withdraw” deadline and subsequently did not submit any work or participate in any exams. Please check with your counselor and financial aid advisor for possible implications of the FW grade on residency and financial aid status.

Missing and Late Policy

All assignments are due at 9pm PST on the due date unless otherwise indicated.

Without a documented excuse, an assignment that is late or missing will receive zero points. That is a large penalty, ugh! But you may receive full credit for completing an assignment late or be given a makeup if you have a documented excuse. Acceptable documented excuses include a dated, signed form from a professional or institution (e.g., health center, doctor, court, cops) or some other written or pictorial indication that events conspired to prevent you from completing your assignment on time. If you are not sure if you have a documented excuse, ask me! We may be able to find one for you. Make-ups normally must be completed within a week of missing them, unless the documented excuse shows why that is a hardship.

If you ever have technical trouble uploading something to Canvas for an assignment, there are two things to do:

1) Email me before the deadline for the assignment and attach a copy of what you are trying to upload.

2) Contact the Canvas help staff through their 24-hour chat option using the ? button on the left-hand Canvas menu. They have a record of every keystroke you make and can find out what went wrong with

your upload. Retain proof of the discussion and outcome. If the problem is on the Canvas side, I can give you an extension.

Course Logistics

Important Dates

These are available when you register and are found in the Syllabus in the Canvas class. Here's the link to the CCSF Semester Calendar

Dropping the Class

If you decide to discontinue this course, it is your responsibility to officially drop it to avoid getting no refund (after 10% of course length), a W symbol (after 20%), or a grade (after 60%). Also, if a student has not participated in their online class for more than three weeks, the instructor may drop or withdraw a student.

Attendance

It may difficult to catch up in ASTR 19 if you begin the class more than two weeks late. (Week 3 is the hardest of all; the content becomes easier after that.) Because of this, and because I often have a very long list of additional students waiting to get in if space is available, I may drop you from the course if you do not access the class within the first three days.

Academic Accommodations for Students with Disabilities

Students seeking disability-related accommodations are encouraged to also register with Disabled Students Programs and Services located in Room 323 of the Rosenberg Library (415) 452-5481. Please see the DSPS website (Links to an external site.)Links to an external site. for more information and alternate locations.

Standards of Conduct

Students who register in CCSF classes are required to abide by the CCSF Student Code of Conduct (Links to an external site.)Links to an external site.. Violation of the code is basis for referral to the Student Conduct Coordinator or dismissal from class or from the College. See the Office of Student Affairs (Links to an external site.)Links to an external site..

Copying on tests in whole or in part is considered an act of academic dishonesty and results in a grade of 0 for that test.

Please avoid any indication of cheating by writing your answers in your own words and submitting your own work. PLAGIARISM = copying other people's or artificial intelligence's words or drawings without giving them credit. Plagiarism will result in zero points for the submitted work. See these links on Plagiarism:

- Encourage Academic Integrity and Prevent Plagiarism (Links to an external site.)Links to an external site.

- Citing Information Sources (Links to an external site.)Links to an external site.

City College of San Francisco is committed to inclusivity, equity and diversity. Students, of varying backgrounds, races, abilities, nationalities, genders, sexual orientations, beliefs, religions, and socio-economic status, have the right to access a higher education and receive the resources and support they need to achieve their educational and professional goals. We welcome, encourage, and engage in diverse perspectives in respectful dialogue. Education is for all who enter the doors of this college.

The San Francisco Community College District is committed to creating and maintaining a community free of all forms of unlawful discrimination, including sex-based discrimination (which includes sexual harassment and sexual violence.) The District has adopted detailed Title IX policies and regulations addressing unlawful discrimination.

Hints for Success

- Go to "Modules" each time you enter our class so you can see each week's material.
- Study the Content Slides carefully, taking notes or whatever method you use to best understand and remember them. Use the textbook, videos and other astronomy educational materials to assist you if you need them.
- Complete the assignments on time each week.
- Study for exams, using the study guides I give you a few weeks ahead of time.
- Please let me know as soon as you can concerning difficulties that you may have so I can make suggestions.
- This course is about topics that you probably don't think about every day, or even at all. We'll see images of glowing gas, dust and stars in space. We will consider the smallest known objects as we figure out the universe's early history. But we'll spend a lot of time on whole galaxies full of many billions of stars and on how many billions of galaxies exist in just our observable universe. This might make you feel kinda small. But remember that you are the part of the universe that is smart enough to figure it all out!

Study Guides

Hints for Studying for Exams

The Content Slides and Key Ideas Reviews along with these Study Guides are your best resource for studying.
The textbook is your secondary resource to assist you in understanding the concepts and definitions.
Practice Dr. Weil's Shortcut for doing math problems.

Consider:

1. Making flashcards based on the Study Guide.
2. Creating an outline of all your notes, week by week.
3. Dividing sections of your notes or book using post-its, sticky, tabs, etc with the specific topics written on them
4. Highlighting the most relevant material in your notes.
5. Looking at the Astro Assistance section on my website.

ASTR 19 MIDTERM STUDY GUIDE

Try to understand at least the basic principles of each concept in the Content Slides. Study your Discussion and Quiz questions too. Do not memorize physical constants or equations because I will have a list of them for you. But you should be able to recognize important equations and understand how they work!

Week 2: Understand scientific (powers of ten) notation and which units go with what quantities (e.g. distance, time, speed). Know how scientific method works. What are astronomical units, light years, and parsecs?

Week 3: Kepler and Newton: What are force, velocity, and acceleration, and angular momentum? Know the difference between mass and weight. Understand Kepler's three laws and Newton's laws of motion. What is Newton's Universal Law of Gravitation? Be able to use it to determine what happens to gravitational force when you increase or decrease the mass of and/or distance between two objects. How do we use Newton's version of Kepler's 3rd law? What are tidal forces?

Week 3: Light and Atoms: What are various types of light (electromagnetic radiation)? Understand the wavelength, speed, and frequency of a light wave. What happens to wavelength when you increase or decrease frequency and vice versa? What are photons? Understand the basic structure of an atom. What is a spectrum of a light source? Know how spectral lines are formed. What happens when an electron moves to a higher or lower level in an atom? How do we tell what elements are in an astronomical object? Understand Wien's Law: how the peak wavelength of a spectrum relates to the temperature of the object that emits the light. Know the Stefan-Boltzmann Law: how the temperature of the object relates to the energy it emits. Understand the Doppler effect. How do we determine whether an astronomical object is moving toward or away from us? Does light need a medium to move in?

Week 4: Know the inverse square law of brightness. How does spectroscopy – the study of the types and widths of spectral lines – help us understand stars? Know how the spectral types of stars – OBAFGKM – relate to their surface temperatures and colors. Understand the main difference between, say, B0, B1, B2… and B9 spectral types. What is the Main Sequence? What are the differences between stars with Luminosity Classes I, III, and V? How do we determine the masses of stars? Which spectral types are most and least massive? How do low mass and high mass stars "die?" What, briefly, happens during a Type II supernova? Understand how heavy elements are created and spread into the interstellar medium.

Week 4: Understand how Einstein's special theory of relativity showed that space and time are related. Do moving frames of reference measure the same values of time and space? Know how Einstein's general theory of relativity addresses acceleration and gravity. How does mass affect spacetime and vice versa? Know a little about Black Holes.

Week 5: What is the interstellar medium mostly made of? What are and what causes emission, reflection, dark, and nebulae? What do stars form from? Where do they form? Are there limits to stellar masses? Where does a protostar's energy come from; what causes a protostar to heat up? What are the properties of Pop I and Pop II stars? Know a little about Barnard Objects, Bok Globules, Herbig Haro Objects, Giant Molecular Clouds.

Weeks 6 and 7: Where did Herschel and Kapteyn think the Sun & Earth were in the Milky Way Galaxy? What caused them to think that? What is the Milky Way Galaxy (MWG)? What is its size and structure? How were they determined? What are globular clusters and how do they help us understand our galaxy? How did/does interstellar dust and extinction affect observations of our galaxy and which wavelengths are affected? What are the nucleus, bulge, disk, halo, and spiral arms of the MWG? What is in them? How do

they move? How do we know our galaxy has spiral arms? Know how 21-cm radiation helps us understand the structure of the disk. How are the spiral arms formed? What and where are Pop I and Pop II stars? How was the Local Bubble created? How do stars orbit in the disk? Know how to determine how long it takes the Sun to orbit once around the MWG. Once that is known, how can we calculate the mass inside the Sun's orbit? What does our galaxy's rotation curve tell us about the mass in the MWG? What is dark matter and how much of it is there and where is most of it? How do we study the nucleus of the MWG and what is found there?

Week 8: How did we learn that the MWG is not the only galaxy? What are elliptical, spiral, S0 and irregular galaxies? How do they differ? What are Sa, Sb, Sc, SBa, SBb, SBc, and E0, E1,… E7 galaxies? What populations of stars do you find in ellipticals? in spirals? In irregulars? What else do you find in them?

ASTR 19 FINAL STUDY GUIDE

Try to understand at least the basic principles of each concept. Study your Discussion and Quiz questions too. Do not memorize physical constants or equations because I will have a list of them for you. But you should be able to recognize important equations and understand how they work!

About 85% of Final Exam on Weeks 8 through 15:

Weeks 8, 9, and 10 on Ch 23: How did we learn that the MWG is not the only galaxy? What are elliptical, spiral, and irregular galaxies? How do they differ? What are Sa, Sb, Sc, SBa, SBb, SBc, and E0, E1,… E7 galaxies? What populations of stars do you find in ellipticals? in spirals? In irregulars? What else do you find in them? What are giant and dwarf ellipticals? Know these methods to find extragalactic distances: RR Lyrae and Cepheid variables, Tully-Fisher relation, Type Ia Supernovae, Masers, Hubble Law. Know how to use Hubble's Law. What causes the cosmological redshift and how can we measure it? Know what a large and small value of z mean.

Know a little about the Local Group. Describe clusters of galaxies, superclusters of galaxies, voids, and walls in the large-scale structure of the Universe. How do galaxies interact with one another? How does hot x-ray gas get into cluster of galaxies? How are starburst galaxies formed? What happens when spiral galaxies merge? Why do we think dark matter exists? What are the four main types of evidence for it? Why did most of the dark matter stay far outside the luminous parts of the galaxy? Know how we think galaxies form. How do angular momentum (spin), rate of star formation, and mergers affect what type of galaxy forms?

Week 11 on Ch 24: What are radio galaxies, quasars, and blazars? What do we observe in each of them that makes them different than normal galaxies? Know why quasar observations were problematic. How was the problem of their distances and sizes/luminosities solved? What are active galactic nuclei and what causes them to be active? What are accretion disks, jets, broad line and narrow line clouds? Why are supermassive black holes causing large luminosity changes? What is the unified model? Why are there no nearby quasars?

Weeks 12 and 13 on Ch 25: How is Olbers's paradox solved? What is the cosmological principle? The Universe expands: what exactly expands, why, how, and how do we know? Understand how lookback time works. Does the Universe have a center? An edge? Understand the balloon analogy. What is the Big Bang?

How old and big is the Universe? Know why the observable Universe is limited to the Cosmic Light Horizon. What is the Planck time? What is the Cosmic Microwave Background Radiation? How was it made and what does it tell us about the creation of the U? What happened in the Universe when it was about 380,000 years old? How hot was the CMB at the Era of Recombination and how hot is it now? Why did the CMB cool? How did that affect the type of light we observe? What happens to temperature and density, matter and radiation in the Universe during its evolution? How uniform is the CMB, and what do its temperature variations or density fluctuations tell us?

What is the shape of space and how is it determined by matter in the Universe? What does the curvature of the Universe depend on? Know about open (hyperbolic), closed (spherical), flat (flat) and accelerating universes and their properties. How do their sizes change with time? How do we measure the curvature of the U and how did we determine it is flat, i.e. has the critical density? Understand the density parameter, $\Omega_{0,}$ including the effects of Ω_m and Ω_Λ. How was the cosmological constant first introduced? What is dark energy? How does it affect the expansion of the U? What observations indicate that it exists? Understand the diagram of Ω_m vs. Ω_Λ.

Weeks 14 and 15 on Ch 26: What are the isotropy (horizon) and flatness problems with the Big Bang Theory and how are they solved by inflation? How big and fast was inflation? What caused inflation? What did it cause? Know about the four fundamental forces and the basics of elementary particles and force carriers. What are GUTs and TOE and which forces do they unify? What is spontaneous symmetry breaking? Which forces separate and when? What was the U like before and after the Planck time? What caused the false vacuum?

Which physical property measurements are limited by the Heisenberg Uncertainty Principle? How does this lead to virtual pairs and what do they do? What is the difference between matter and antimatter? What are pair production and annihilation? How are matter and radiation created in the U? When, why, and how does the creation of matter cease? Why is the U made of matter instead of antimatter? If the asymmetry had not occurred, what would the U be made of? What are neutrinos? What is the neutrino background like now and why is it hard to observe? How are hydrogen and helium formed in nucleosynthesis? Are other elements formed? What do quantum density fluctuations grow into? Why does dark matter stay in halos of galaxies and gas collapse to the center? What is the difference between the bottom-up cold dark matter model and the top-down hot dark matter model?

Up to 15% of Final Exam on the following concepts:

Weeks 2 and 3 on Chs 1, 4, 5: Understand scientific (powers of ten) notation. What are light years and parsecs? Understand Newton's Universal Law of Gravitation, i.e. what happens to gravitational force when you increase or decrease the mass of and/or distance between two objects. What do we use Newton's version of Kepler's 3rd law for? What are the various types of light/electromagnetic radiation/photons? Understand how measuring spectral lines tell us what elements are in an astronomical object. Understand how the Doppler effect and how shifts in spectral lines tell us whether an astronomical object is moving toward or away from us.

Week 4 on Chs 17, 19, 20, 21: Know how the spectral types of stars – OBAFGKM – relate to their surface temperatures and colors. What are the differences between stars with Luminosity Classes I, III, and V? How do low mass and high mass stars "die?" Understand how heavy elements are created and spread into the interstellar medium. Understand that Einstein's special theory of relativity showed space and time are related and that Einstein's general theory of relativity addresses acceleration and gravity.

Week 5 on Ch 18: How did/does interstellar dust and extinction affect observations of our galaxy and which wavelengths are affected? What is the interstellar medium mostly made of? What causes emission, reflection, dark, and nebulae? What are the steps of star formation? Are they different for low and high mass stars?

Weeks 6 and 7 on Ch 22: How were the size and structure of the Milky Way Galaxy (MWG) determined? What are the differences among nucleus, bulge, disk, halo, and spiral arms of the MWG? What and where are Pop I and Pop II stars? Know how 21-cm radiation helps us understand the spiral structure of the disk. How are spiral arms formed? How do we calculate the mass of the MWG? What does our galaxy's rotation curve tell us about the mass in the MWG? What is dark matter and how much of it is there and where is most of it? What is found in the nucleus of the MWG?