**INST 2403-01 THE EXPANDING UNIVERSE SPRING 2020**

**Syllabus**

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**Classroom:** Library 118 **Time:** MWF 9:10-10:05 a.m.

**Office hours:** MWF 11:15am – 12:15pm, or by appointment.

**Course Catalog Description:** “The most incomprehensible thing about the universe is that it is comprehensible”–Albert Einstein. This course engages students in a bottom-up study of the universe. Starting on planet Earth, we trace our expanding understanding of the cosmos from its intellectual and methodological beginnings. Students participate in several observational and experimental activities.

Welcome to this class! As part of the INST requirement, this course is an integral part of your education, but the course’s subject may be out of your area of expertise. For these reasons you probably have to work at least as hard for this course as you would for a major class. As a rule of thumb, plan to spend two hours outside of class studying for every hour spent in class. Therefore, this three semester credit hour course requires at least six hours per week of out-of-class work.

**TEXT:** *Constructing the Expanding Universe*, by Uwe Trittmann (First Edition, Cognella Academic Publishing, 2019)

**WEB PAGE:** http://faculty.otterbein.edu/UTrittmann/is2403-01. This is not a Blackboard site!

**ABOUT THIS COURSE:** There are two sides to the expansion of the universe. On the one hand, the universe physically expands, whether we are aware of it or not. On the other hand, our understanding of the physical world keeps expanding. We came to know, from practical and humble beginnings, that we live on a rather small planet orbiting an average star in one of the trillions of galaxies in the universe. This is a far cry from our initial belief that we are situated at the center of the universe. We will follow the fascinating story of how we came to know the universe in ever greater detail, freeing ourselves from false conclusions by careful observation and reasoning. The road to an adequate understanding of the natural world is a long, rocky, and winding one. We will engage with the concepts and knowledge that have been obtained by the sustained efforts and sacrifices of scientists over many centuries. We will inquire why we trust these concepts and why they have proven useful in describing the natural world. Many things we take for granted today and our ease of life are largely based on scientific progress and the toiling of humans before us. It is only fair that we work hard to come to grips with the scientific description of the physical world to be able to do our share to improve our lot. Mastering mathematics (the language of the universe according to Galileo) enables us to appreciate the scientific view of the world with its strengths and limitations. It is but one possible description of the world we live in, and it is subject to continuous updating, but it is the most basic, straightforward, failsafe and logical one. It is the basis of all rational decision making we are to do every day as responsible global citizens.

As we strive to understand astronomical concepts and their implications for our lives, let us not forget how wonderful of a topic astronomy is. We will stop and observe the sky as often as possible: to get hands-on experience with scientific practices, to marvel at its beauty, and to be inspired for our endeavor to comprehend the heavens. After all, inspiration and motivation are the most important prerequisites for true learning and understanding.

**COURSE OBJECTIVES:** This course aims to fulfill the general theme of the IS program “Knowledge, Action, and the Public Good” by introducing you to a topic outside of your major. You will gain *knowledge* of new concepts, facts, terms and jargon. The focus is on acquiring an appreciation of the scientific way of knowing and analytic problem solving. This will enable you – in your role as a citizen – to make good decisions and put your education into *action.* You will come to see an understanding of the natural world, our place in it, and, in some sense, knowledge itself as a *public good.* It addresses the following for specific outcomes associated with the Natural Foundations thread:

* Students can articulate how their learning enables them to contribute to some aspect of the public good (*Outcome 1*).
* Students can reflect on the different ways of knowing, inquiring, and creating represented by the different disciplines (*Outcome 3*).
* Students can analyze the ways in which our lives are structured by social relationships, cultural exchange, and/or our place in the natural world (*Outcome 6*).
* Students can demonstrate that they see themselves as responsible, engaged, and informed citizens capable and willing to act in ways that will serve the public good (*Outcome 8*).

In sum, the course exposes you to creative and critical thinking as practiced in science through the formulation and testing of hypotheses, and give you ways to think critically about political choices involving technological issues. The best possible outcome of the course is that it will excite your curiosity about science and the universe, and prepare you to explore your interests further on your own. This course is an invitation to become an independent thinker, able to tell whether something makes sense or not – with your own mental capabilities, without looking it up on the internet. As an **INST outcomes assessment**, your scores on the first midterm exam will be used (85-100% = “exceeds”, 65-84% = “meets”, below 65% = “fails to meet the outcome”). The exam is reflective of *Outcome 6,* in that we learn in the first part of the course how “our lives are structured by (…) our place in the natural world”, specifically: in the solar system.

**TEACHING PHILOSOPHY:** I will use a variety of active teaching styles, since educational research has shown them to be effective. In particular, I’ll be using the “***peer instruction***” method developed by Mazur at Harvard University. Peer instruction is based on the well-documented effect that we all learn better if we (try to) explain something to other people. Through the process of interaction with your peers, you’ll share in the benefit of active learning: by arguing with others, the *concept* will become embedded in your mind, and not just a collection of facts. We will also be working through ***activities*** in small groups, see below.

**ASSIGNMENTS, REQUIREMENTS AND EXAMS**

**Activities.** The activities will be performed by a group of students in class, and will provide hands-on experience with astrophysical and scientific concepts and methods, like position, motion, measurements, etc. Some activities are announced in the syllabus, others will be instigated as needed and may take place in mid-class. To receive credit, each group hands in a brief summary of the results of the activity.

**Rooftop visit.** Attend one of the sessions at the Weitkamp Observatory on top of Otterbein’s science building. To receive credit, hand in a short written description of what you observed and what you learned about the night sky and/or astronomical tools. (You may substitute a visit to Perkins Observatory, or a visit at the planetarium at OSU for one rooftop visit. To receive substitute credit, you must hand in some form of proof that you attended, such as a ticket stub, or a program signed by the speaker, and write a paragraph describing the program.)

**Homework.** Homework problems will be assigned weekly via WebAssign, a web-based system for creating and grading assignments. If you are having trouble solving the problems, you should talk to me or ask questions in class. You have to pay an access fee which can be done online as you log on. There is a grace period of roughly a week, but after that you will not be able to do your homework unless you pay the fee. To connect to the system, go to: **http://www.webassign.net/student.html**. Then, to log on enter: your **username,** the institution name (Enter "**otterbein**" here (all lower case)), your **password**. Your password and username are initially set to the first letter of your first name followed, without space, by your last name, all lowercase letters, e.g. “utrittmann”. You should change the password once you log on.

Once you log in you will see a list of current and past assignments, beginning with an introduction to WebAssign that will help you get oriented. If you have any problems using WebAssign, come see me ASAP! Assignments will be due Friday evening (but check the schedule) so you can ask question in class and even come to the office hours on Friday. After the deadline, solutions will become available. Since the system is computerized, no late homework can be accepted.

**Exams:** There are two midterm exams and one final exam.The final exam is ***comprehensive***. It covers the material of the entire semester. There are no make-up exams, see “Attendance”. Most of the exam question will be of the multiple-choice type. You will not be able to leave the classroom during the exams (no bathroom breaks).

**Grades:** Assignments and exams will have the following weight in determining your final grade:

|  |  |
| --- | --- |
| **Assignment** | **Weight** |
| Rooftop Visit + Essay | 3%  |
| Activities | 10% (total) |
| Participation | 4% |
| Constellation quiz | 7% |
| Homework | 20% |
| 2 in-class tests 18% each | 36% |
| Final exam | 20% |

**Constellation quiz.** You will be asked to identify stars and constellations on a star chart.

**Participation:** Educational research shows that we learn best when we have to articulate our ideas; it clears and streamlines our thoughts. I therefore will solicit answers to pedagogically phrased questions. To encourage answers I will give credit based on your participation in these class discussions. I may also call on people to stimulate discussion.

**Readings:** I expect you to do the readings (mostly from the textbook) listed in the schedule before class. Read them thoroughly: if you come to classes prepared, you will get a lot more out of the lectures. Supplementary online readingscan be found on the course homepage.The webpage will be updated during the course. Check before the assigned reading for changes.

**Cultural Event Attendance and Participation Policy:** Please attend 2-4 cultural events (see <http://www.otterbein.edu/public/Academics/SchoolsUniversityPrograms/UniversityPrograms/integrativestudies/events.aspx> for INST approved events), and send me an email with a brief response to the event. At least two of the required events should be part of the #cardsSTANDtogether program. Contact the Office of Social Justice and Activism for more information: <http://www.otterbein.edu/public/CampusLife/ServicesAndResources/OSJA.aspx>.

**COURSE POLICIES**

**1. Attendance.** Attendance is required for tests and activities. There are no make-up exams. If you have a legitimate, foreseeable reason that you must miss an exam during the term, you must contact me at least a week in advance to make alternative arrangements. If you unexpectedly miss an exam for a documented legal or medical reason, I will assign you the average score of your other exams, if I am informed within 48 hours. The policy for missed activities is the same as for midterm exams. Exceptions to the final exam schedule are allowed only by permission of the Academic Dean.

**2. Late work.** No late homework can be accepted, see above. Other late assignments will lose 10% credit per day. ***No*** *work will be accepted after the last lecture.*

**3. Cell phones, texting devices, and such** can be very disruptivein class, interfere with learning, and therefore have to be turned ***off*** for the entire class period.

**4. Learning Differences:**  If you have a documented learning difference please contact Kera McClain Manley, the Disability Services Coordinator, to arrange for whatever assistance you need. The Disability Services is located in Room #13 on the second floor of the Library in the Academic Support Center. You are welcome to consult with me privately to discuss your specific needs. For more information, contact Kera at kmanley@otterbein.edu, 614-823-1618 or visit the Disability Services at the following web link: <http://www.otterbein.edu/public/Academics/AcademicAffairsDivision/AcademicSupportCenter/DisabilityServices.aspx>.

**5. Academic Honesty:** All academic work should be your own. Academic dishonesty (plagiarism and cheating) may result in automatic failure of the assignment or the course itself, and you will be referred to the Academic Affairs Office for suspension or expulsion proceedings.

You are plagiarizing when you:

1. Copy material from a source without using quotation marks and proper citation.

2. Follow the movement of the source, substituting words and sentences but keeping its meaning, without citing it.

3. Lift phrases or terms from a source and embed them in your own prose without using quotation marks and proper citation.

4. Borrow ideas (that are not common knowledge) form a source without proper citation.

5. Turn in a paper wholly or partially written by someone else.

The complete statement on Plagiarism, Cheating and Dishonesty can be found in the Campus Life Handbook, page 33, at the following web link: <http://www.otterbein.edu/public/CampusLife/HealthAndSafety/StudentConduct.aspx>.

**STUDY SUGGESTIONS**: The best way to prepare for the exams is to review the material in the textbook (the text, obviously; learning goals, chapter summaries, and review questions might be particularly useful), the homework and your lecture notes including the concept questions, and activities we will work on in class. Look for recurring concepts to find the relevant information. If we talked about something in class, it appeared in a homework problem and in the textbook, it might be an important concept that will likely find its way into the exam. In general, exam questions will be on concepts rather than on facts. For instance, I will not ask you what year Galileo died, but I may ask what the phase of the moon will be a week after it was full.

**TENTATIVE SCHEDULE OF READINGS, ASSIGNMENT DUE DATES AND EXAMS**

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Topic | Reading  | Assignments  |
| M | Jan 13 | Introduction, Patterns in the Sky |  |  |
| W | Jan 15 | Patterns in the Sky, Constellations | 1.1 | Activity: Observing & Angles |
| F | Jan 17 | Astronomy as a Science | 1.2 | ***HW #1 due*** |
| M | Jan 20 | **MLK DAY – No classes** |  |  |
| W | Jan 22 | Daytime observing (Sun,South,Noon) | 1.3 | Activity: Position |
| F | Jan 24 | Daily Motion | 1.3 | **Constellation Quiz; *HW #2 due*** |
| M | Jan 27 | Introduction to Seasonal Motion  | 1.4 |  |
| W | Jan 29 | Seasonal Motion | 1.4 | Act.: Seasonal Motion, seasons |
| F | Jan 31 | Motion of the Moon | 1.5 | ***HW #3 due***  |
| M | Feb 3 | Phases of the Moon | 1.5 | Act.: Moon Phases |
| W | Feb 5 | Motion of the Planets | 1.6 | Activity: Retrograde Motion |
| F | Feb 7 | Homework, Discussion, Conclusion  |  | ***HW #4 due***  |
| M | Feb 10 | ***Midterm Exam I*** |  |  |
| W | Feb 12 | History of Astronomy | 2.1 – 2.3  | Act.: Parallax, Moon Distance |
| F | Feb 14 | Ptolemy | 2.4 | ***HW#5 due***  |
| M | Feb 17 | The Copernican Revolution  | 2.5  | Activity: Epicycles |
| W | Feb 19 | Tycho & Kepler  | 2.6 + 2.7 | Activity: Kepler’s Laws  |
| F | Feb 21 | Galileo & Scientific Revolution | 2.8 +2.9 | ***HW #6 due***; Act.: Venus’ Phases |
| M | Feb 24 | Newton’s Laws & Gravity | 2.10 | Activity: Newton’s Laws |
| W | Feb 26 | The Scale of the Cosmos  | 3.3 + 3.4 |  |
| F | Feb 28 | Telescopes | 3.6 | ***HW #7 due;*** Act.: Telescopes |
| M | Mar 2 | **Semester Break – No classes** |  |  |
| W | Mar 4 | **Semester Break – No classes** |  |  |
| F | Mar 6 | **Semester Break – No classes** |  |  |
| M | Mar 9 | EM Radiation  | 3.7 | Act.: Spectra |
| W | Mar 11 | Thermodynamics & Astrophysics | 3.8 + 3.9 | Act.: BB radiation |
| F | Mar 13 | Introduction to the Solar System  | 4.1 | ***HW #8 due*** |
| M | Mar 16 | Atmospheres & Greenhouse Effect | 4.3 | Activity: Greenhouse Effect |
| W | Mar 18 | Formation of the Solar System | 4.5 | Activity: SS Formation |
| F | Mar 20 | The Closest Star  | 4.6 | ***HW #9 due*** |
| M | Mar 23 | ***Midterm Exam II*** |  |  |
| W | Mar 25 | Modern Physics at a Glance  | 5.1 |  |
| F | Mar 27 | Stars & HR diagrams | 5.2 | ***HW #10 due***  |
| M | Mar 30 | Modeling Stars | 5.3 | Activity: HR diagrams |
| W | Apr 1 | Energy “Production” in Stars | 5.4 | Activity: Stellar Lifetimes |
| F | Apr 3 | Stellar Lifecycle  | 5.5 | ***HW #11 due*** |
| M | Apr 6 | Death of Stars & Nucleosynthesis | 5.6 |  |
| W | Apr 8 | The Milky Way  | 6.1 | ***HW #12 due*** |
| F | Apr 10 | **GOOD FRIDAY – No classes** |  |  |
| M | Apr 13 | Galaxies | 6.2 | Activity: Milky Way Scales |
| W | Apr 15 | Introduction to Cosmology  | 6.3 | Activity: Cosmology |
| F | Apr 17 | Homework, Discussion |  | ***HW #13 due*** |
| M | Apr 20 | Cosmic Distance Ladder | 6.3 | Activity: Cosmic Yardsticks |
| W | Apr 21 | The Expanding Universe | 6.4 | Activity: Einstein & Cosmology |
| F | Apr 23 | The Failure of Standard Cosmology | 6.5 | ***HW #14 due;*** Act: Exp. Universe |
| W | Apr 29 | **Final Exam (8:00 – 10:00 a.m.)** |  |  |