**Introduction to Astronomy**

**AST K111 Instructor:** Professor William J. Dopirak, Jr.

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# Three Rivers Community College

**Norwich, CT 06360 Office Loc: C-130**

**Office Hours: Tuesday –** 3:00 – 4:00 pm **Thursday:** 2:00-4:00pm(Or by appointment)

**Required Text:**

**1)** Moche, Dinah L. 2015. Astronomy: A self-teaching guide. 8th edition. John

Wiley & Sons, Inc. 363p. ISBN 978-1-62045-990-4

**Supplementary material:**

1. Miller Planisphere, star charts, field guides, binoculars and/or telescopes

**Catalog Description:**

In addition to understanding the mechanisms involved in ascertaining distance, temperature and movements of celestial bodies, students will be able to orientate themselves with the night sky by using constellations as guides. This material will also cover the ideas that account for the earth and heavenly bodies and their characteristics. This course is designed to develop an appreciation of the beauty and order of the universe. The laboratory portion of the course consists of activities in elementary astronomy designed to reinforce and extend knowledge of selected topics covered in the lecture portion of the course. *Students who have taken AST\* K101 will not receive credit for this course.*

**Primary Objectives:** In addition to understanding the mechanisms involved in

ascertaining distance, temperature, and movements of celestial bodies, students will

be able to orientate themselves with the night sky by using constellations as guides.

**Attendance Policy:**

Students are expected to attend class sessions regularly. If a class is missed due to circumstances beyond your control, **please**, be sure to notify your instructor and make the necessary arrangements for obtaining the lecture notes. **You will be responsible** for the material. **If 3 classes are missed, a deduction of 5-POINTS will be taking from your final grade. TEN-POINTS will be deducted from your final grade if 5 or more classes are missed.** A 5-point bonus will be added to your final grade if 100% attendance is noted.

**Grade Evaluation:**

There will be two exams, a mid-term and the final exam. There will be (AT LEAST) eleven weekly quizzes. The lowest quiz grade will be dropped. Exam and quiz questions will consist of multiple choice, short answers, and/or essays. Every student is responsible for at least one “Constellation Report” AND a “Research Project".

Your constellation report will consist of describing the stars that make up that constellation. You must sign up for your constellation (Table 1), and report on it in front of the class.

Your special report will consist of a research project of your choice. More will be discussed on these throughout the semester.

**Add/Drop Procedures:**

Please consult the school catalog for this policy.

*Ten percent of your AST K111 final grade will consist of a Constellation Report.*

The constellation report must include celestial coordinates of your constellation and characteristics of each star in that constellation. You must indicate where on the Herztsprung-Russell (H-R) diagram, the types of stars in your constellation. The luminosity, distance, and star names must also be included in this report. Nebulae and galaxies also may be in your constellation that you will incorporate in your report. You may also add any mythology associated with your constellation.

**-AND -**

*Ten percent of your AST K111 final grade will consist of a Research Project.*

The research project may include a 3-page report on a current astronomic issue.

More creative projects may include:

1. Monitoring the moons hourly shadow and angle, during a full or gibbous phase.
2. Follow the moon daily for one synodic month.
3. Record, semi-weekly, sunsets throughout the semester.
4. Follow and record the movement of the circumpolar stars
5. Monitor the movements of the planets throughout the semester
6. Measure the angle of the noonday sun throughout the semester.
7. Any other creative idea you may have, ***but please check with me first***.

**Grading:**

Final grade will based on the following:

Exams------------------------60%

Quizzes-----------------------10%

Lab reports-------------------10%

Research project------------10%

Constellation report--------10%

100%

**Final Grade:**

100.0-99.0= A 79.4-77.5= C+

98.9-93.5= A 77.4-72.5= C

93.4-90.5= A- 72.4-69.5= C-

90.4-87.5= B+ 69.4-63.5= D+

87.4-84.5= B 63.4-59.5= D

84.4-79.5= B- 59.4-00.0= F

**College Withdrawal Policy:**

A student who finds it necessary to discontinue a course once class has met must provide written notice to the registrar. **See Registrar for dates.**  After that period, a student wishing to withdraw must obtain written authorization of the instructor to receive a "W" grade on their academic record, non-punitive grade indicating termination of class participation. Students who do not withdraw, but stop attending **will receive** a grade of "F" for the final grade. **Verbal withdrawals cannot be accepted**.

**Disabilities Statement:**

If you have a hidden or visible disability, which may require classroom or test-taking modifications, please see me as soon as possible. If you have not already done so, please be sure to register with the college disability counselors by contacting Student Services Office.

* Matt Liscum, Counselor: (860)215-9265 (Room A-113)
  + Learning Disabilities
  + ADD/ADHD
  + Autism Spectrum
  + Mental Health Disabilities
* Elizabeth Willcox, Advisor: (860)215-9289 (Room A-113)
  + Medical Disabilities
  + Mobility Disabilities
  + Sensory Disability

**Academic and Classroom Misconduct:**

The instructor has the primary responsibility for control over classroom behavior and maintenance of academic integrity, and can order the temporary removal or exclusion from the classroom, and/or laboratory, of any student engaged in conduct violative of the general rules and regulation of the institution. Extended or permanent exclusion from classroom, and/or laboratory, or further disciplinary action can be effected only through appropriate college procedure. Plagiarism, cheating, or any form of academic dishonesty is **prohibited**. Students guilty of academic dishonesty directly or indirectly will receive a **zero** for an exercise or exam and may receive an **F** for the course in addition to other possible disciplinary sanctions that maybe imposed through the regular institutional procedures. Any student that believes he or she has been erroneously accused may appeal the case through the appropriate institutional procedures if their grade was affected.

**Digication:** All students are required to maintain an online learning portfolio in Digication that uses the college template. Through this electronic tool students will have the opportunity to monitor their own growth in college-wide learning. The student will keep his/her learning portfolio and may continue to use the Digication account after graduation.

A Three Rivers General Education Assessment Team will select and review random works to improve the college experience for all. Student work reviewed for assessment purposes will not include names and all student work will remain private and anonymous for college improvement purposes. Students will have the ability to integrate learning from the classroom, college, and life in general, which will provide additional learning opportunities. If desired, students will have the option to create multiple portfolios

**Introduction to Astronomy**

**Tentative Schedule**

# Fall 2018

**Lecture:** T & R: 5:00-6:15pm (A-221)

**Lab:** T & R: 6:30-7:45pm (A-221)

**Required readings in:**

Moche 2015

## Week Topic Chapter #’s

**1** Introduction/**Lab:** Time Zones

The “New” Solar System/Celestial Orientation **1**

**2** **Lab:** *Seaport Planetarium Field Trip, Mystic, CT*

Measurable Time/Lunation/Eclipses **8**

**3** **Lab:** Equatorial Coordinate System

Angulations/Parallax

**4** **Lab:** Moon motions and phases **10**

Historic aspect of Astronomy

**5** **Lab:** Celestial sphere

Newtonian Physics/Kelper’s Laws **8**

**6** **Lab:** Kepler's laws applied

Tools of the Trade: Types of and physics of Telescopes **2**

**7** **Lab:** Optics and wave drawing

**Mid-Term Exam**

**8** **Lab:** Spectrometry **3**

Our Sun/Stellar Luminosity **4**

**9** Temperatures & Brightness of Stars/H-R Diagram **3**

**Lab:** Constellation reports

**10** **Lab:** Constellation reports

Structure of stars **5**

**11** **Lab:** Constellation reports

Stellar births & Deaths **5**

**12** **Lab:** Galaxies

Galaxies **6**

**13** **Lab:** Observation and identification exam

Comparative Planetology **9**

**14** **Lab:** Wrap up

Comparative Planetology (cont.)

**15** Review for final

**FINAL EXAM**

Quizzes will be on previous lecture material

**Syllabus Revisions:**

This schedule may be subject to change as the instructor sees fit. The instructor will announce any changes in advance.

# Introduction to Astronomy

**AST K111**

**Detailed Objectives**

Upon completion of this course the student should be able to:

1. List the main constituents of our solar system, galaxy, and universe.
2. Describe a few of the exciting topics being investigated by modern astronomers.
3. Outline some key events in the history of the Universe.
4. Construct a scale model of the Universe that illustrates the relative distances and sizes of various celestial objects.
5. Discuss how time (*as we perceive it*), is influenced by distance.
6. Explain the foundations of anthropogenic calendars.
7. Understand the use of scientific notation and the metric system.
8. Discuss sidereal time and how it relates to a synodic month.
9. Describe the lunar cycle and its effects on earth.
10. Understand stellar parallax and parsecs.
11. Summarize some of the accomplishments of early Greek Astronomers.
12. Discuss the models of the Universe developed by Aristotle, Ptolemy, and Copernicus.
13. State and apply Kepler’s three laws of planetary motion.
14. Discuss the importance of geometric principles in association with astronomy.
15. Discuss Newton’s contributions to Astronomy, physics, and mathematics.
16. State Newton’s three Laws and examples of each.
17. Describe Newton’s Law of universal gravitation, and summarize the reasoning used by Newton to deduce it.
18. Explain how we can say that the Moon is falling towards Earth.
19. Compare and contrast the properties of the terrestrial and the jovian planets.
20. Explain why Mercury’s night and day are twice as long as its year.
21. Explain what the “Greenhouse Effect”, both stable and runaway, and apply it to the atmosphere of Venus.
22. Understand Earth’s dynamic properties; plate tectonics and atmosphere.
23. Discuss the Martian landscape, atmosphere, and possible life.
24. Summarize Jupiter’s four main moons.
25. Describe the appearance, origin, and nature of Saturn’s rings.
26. List some discoveries made when Voyager II visited Uranus and Neptune.
27. Explain what a “Shooting Star” is.
28. Discuss the origin of comets, as well as their physical and orbital properties.
29. Summarize the methods used by astronomers to detect and study light.
30. Sketch the path of light rays follow in different types of telescopes.
31. State the main purposes of telescopes.
32. Calculate the relative light-gathering power of two telescopes, given their diameters.
33. Explain the different types of optical telescopes.
34. Explain why radio telescopes are much larger than optical telescopes.
35. Discuss the nature of electromagnetic radiation.
36. Define what is meant by a spectrum, and identify the electromagnetic region that visible light occupies.
37. Explain the nature of light and its properties.
38. Define wavelength, frequency, period, and speed of a wave.
39. State the relationship between energy and frequency (for wavelength) of a photon.
40. Summarize some arguments for thinking that light has both wave-like and particle-like properties.

**Table 1.** A compiled list of recognized constellations found in most star charts and planispheres.

|  |  |  |
| --- | --- | --- |
| Constellation | **Abbreviation** | **English Translation** |
| Andromeda | And | Princess |
| Antlia | Ant | Air Pump |
| Aquarius | Aqr | Water Bearer |
| Aquila | Aql | Eagle |
| Ara\* | Ara | Alter |
| Aries | Ari | Ram |
| Auriga | Aur | Charioteer |
| Boötes | Boo | Herdsman |
| Caelum | Cae | Burin (engraving tool) |
| Camelopardalis | Cam | Giraffe |
| Cancer | Cnc | Crab |
| Canes Venatici | CVn | Hunting Dogs |
| Canis Major | CMa | Big Dog |
| Canis Minor | CMi | Little Dog |
| Capricornus | Cap | Sea Goat |
| Cassiopeia | Cas | Queen |
| Centaurus\* | Cen | Part Human and Part Horse |
| Cepheus | Cep | King |
| Cetus | Cet | Whale |
| Columba | Col | Dove |
| Coma Berenices | Com | Berenice’s Hair |
| Corona Australis | CrA | Southern Crown |
| Corona Borealis | CrB | Northern Crown |
| Corvus | Crv | Crow |
| Crater | Crt | Cup |
| Cygnus | Cyg | Swan |
| Delphinus | Del | Dolphin |
| Dorado\*\* | Dor | Swordfish |
| Draco | Dra | Dragon |
| Equuleus | Equ | Little Horse |
| Eridanus\*\* | Eri | River |
| Fornax | For | Furnace |
| Gemini | Gem | Twins |
| Grus\* | Gru | Crane |
| Hercules | Her | Hero (Divinity) |
| Horologium\*\* | Hor | Clock |
| Hydra | Hya | Water Monster |
| Indus\* | Ind | Indian |
| Lacerta | Lac | Lizard |
| Leo | Leo | Lion |
| Leo minor | Lmi | Little Lion |
| Lepus | Lep | Hare |
| Libra | Lib | Scales |

\*southern constellation, shown in part from this latitude

\*\*southern constellation, no stars may be seen from this latitude

**Table 1. (cont.)**

|  |  |  |
| --- | --- | --- |
| Constellation | **Abbreviation** | **English Translation** |
| Lupus\* | Lup | Wolf |
| Lynx | Lyn | Lynx |
| Lyra | Lyr | Lyre |
| Microscopium | Mic | Microscope |
| Monoceros | Mon | Unicorn |
| Norma\* | Nor | Set Square |
| Ophiuchus | Oph | Serpent Bearer |
| Orion | Ori | Hunter |
| Pegasus | Peg | Winged Horse |
| Perseus | Per | Prince |
| Phoenix\* | Phe | Immortal Bird |
| Pictor\* | Pic | Painter’s easel |
| Pisces | Psc | Fishes |
| Pisces Austrinus | PsA | Southern Fishes |
| Puppis\* | Pup | Stern of a ship |
| Pyxis | Pyx | Mariner’s Compass |
| Sagitta | Sge | Arrow |
| Sagittarius | Sgr | Archer |
| Scorpius | Sco | Scorpion |
| Sculptor | Scu | Sculptor |
| Scutum | Sct | Shield |
| Serpens | Ser | Serpent |
| Sextans | Sex | Sextant |
| Taurus | Tar | Bull |
| Telescopium\* | Tel | Telescope |
| Triangulum | Tri | Triangle |
| Ursa Major | Uma | Big Bear |
| Ursa Minor | Umi | Little Bear |
| Vela\* | Vel | Sails |
| Virgo | Vir | Virgin |
| Vulpecula | Vul | Little Fox |
| Apus\*\* | Apu | No Feet |
| Carina\*\* | Car | Keel |
| Chamaeleon\*\* | Cha | Chameleon |
| Circinus\*\* | Cir | Compass |
| Crux\*\* | Cru | Southern Cross |
| Hydrus\*\* | Hyd | Hydra |
| Musca\*\* | Mus | Housefly |
| Norma\*\* | Nor | Right Angle |
| Octans\*\* | Oct | Octant |
| Pavo\*\* | Pav | Peacock |
| Reticulum\*\* | Ret | Crosshair |
| Tucana\*\* | Tuc | Toucan |

\*southern constellation, shown in part

\*\*southern constellation, no stars may be seen

# Introduction to Astronomy

# AST K111

# Detailed Outline

# 

# I Introduction

**a)** Observational Science

**b)** Positions, movements, and evolution of celestial bodies

**c)** One of the oldest sciences

-thousands of years of observations

# A) Movement of Earth

1. Rotation vs Revolution
   * 1. Rotation velocity
     2. Revolution velocity
2. Inclination
3. Precession
4. Astronomic Unit

# B) The “New” Solar System (2010)

1. μ – value
2. Pluto?
3. ‘dwarf’ planets
4. Debris and a host of asteroids
5. Sun is a star

# C) Beyond the Solar System

1. Milky Way Galaxy
2. Local Group
3. Local Supercluster
4. “Virgo Cluster”
5. Astronomical Hierarchy

# D) Brief overview of scientific notation & metric system

1. Scientific notation
   * 1. Exponential Notation

**b)** Metric System

**c)** Absolute (Kelvin) scale

# E) Terrestrial Latitude and Longitude

1. degrees(°)
2. minutes (’ )

**c)** seconds (”)

**d)** Latitude

**e)** Longitude (Meridians)

**f)** Time zones

# II Celestial Sphere

##### Sky measures

1. Celestial Coordinates
   * 1. Celestial Poles
     2. Celestial equator
     3. Horizon and Zenith
2. The Ecliptic
   * 1. Spring (vernal) Equinox & Autumnal Equinox
3. Analemma

**e)** Zodiacal constellations

**B) Alt/Az System**

1. Altitude
2. Azimuth

**C) Equatorial Coordinate System (ECS)**

1. Right Ascension
2. Declination

## D) Earth’s Seasonal Fluctuations

1. Solistice
2. Equinox

III Relative Position & Movement of the Moon from Earth

**A) Phases of the moon**

* 1. Synodic Month
  2. Sidereal Month
  3. Lunar cycle
     + 1. waxing waning phases
       2. waning gibbous

B) Eclipses

1. Nodes

1. Umbra

2. Penumbra

1. Lunar eclipses
2. Solar eclipses

1. Annular

* + - 1. Total
      2. Partial

## IV Time and Distance

**A) Lunation & lunisolar calendars**

**B) Angular Measurement of Distance**

1. Physical size and Distance of an object
   * 1. Angular size vs Distance

##### C) Time

1. Rotational time
2. Dynamic Time
3. Ephemeris Time
4. Atomic Time
5. International Standards

**C) Time** **(cont.)**

1. Twilight
   * 1. Civil Twilight
     2. Nautical Twilight
     3. Astronomical Twilight
2. Calendar Year
3. Babylonian calendar
4. Chinese Calendar
5. Muslim Calendar
6. Jewish Calendar
7. Egyptian Calendar
8. Roman Calendar
9. Julian Calendar
10. The Gregorian Calendar
11. Japanese Calendar
12. Today’s Calendar
13. Other Calendars of Note
    * 1. Julian Day Calendar
      2. Perpetual Calendar
      3. World Calendar

# s) Timeline of Astronomy

1.Archeoastronomy

* + - 1. Timeline of Ancient Astronomy

# V History of Astronomy

**A) Pre-Renaissance**

1. Aristotle
2. Aristarchus
3. Erastosthenes
4. Ptolemy

**B) Copernicus Revolution**

1. Nicolaus Copernicus
2. TychoBrahe
3. Johannes Kepler
   * 1. Kepler’s laws of planetary movement
        1. *“Harmonic Law”*
4. Galileo Galilei
5. Isaac Newton
   * 1. Newton’s 3 Laws of Motion

##### The Universal Law of Gravity

# Inverse square of distance (1/d2)

# Gravitational Law: FG = -G(Mm/d2)

**c)** How gravity produces an orbit

**d)** Gravity and Inertia

**e)** Newton derived and generalized Kelper’s 3 Laws

**f)** Newtonian Physics Summary

**C) Electromagnetic forces**

1. The world of physics
2. Uncertainty Principle”
   * 1. Quarks
     2. Leptons
     3. Bosons
3. Strong Nuclear
4. Weak Nuclear
5. Gravity

# VI Modern Astronomy

**A) Quantum physics**

1. Einstein’s “Theory of Relativity”
   * 1. Stage 1:“Special Relativity”
        1. E = m*c*2

**i.** Stage 2: “General Theory of Relativity”

**b)** Hubble

**c)** “Big-Bang Theory”

# VII Light and Telescopes

**A) Light**

**B) Electromagnetic Radiation**

**a)** Oscillating electric & magnetic fields

**b)** Speed of light (*c*) = 300,000 km/s (186,000 mi/s)

1. wavelength = speed of light divided by the frequency

λ = *c* / *f*

###### C) Optical Telescopes

1. Sidereal drive
2. Equatorial Mounting
3. Alt-Azimuth Mounting
4. Refracting telescopes
5. Reflecting telescopes
6. achromatic lens
7. Newtonian focus
8. Cassegrain focus
9. Schmidt-Cassegrain telescope

# D) Powers of Optical Telescopes

1. Light-gathering power (brighter)
   * 1. area of lens (or mirror) diameter = (D/2)2
2. Resolving power (clearer)
   * 1. Diffraction fringe
3. Magnifying power (larger)
   * 1. Focal length

### E) Radio Telescopes

**a)** Radio interferometer

# VIII The Sun

* 1. **Sunspots**

##### Prominences

##### Dark Filaments

##### Solar Flares

##### Solar atmosphere

1. Photosphere
2. Chromosphere
3. Corona
   1. **Granulation**
   2. **Coronal mass ejections (CMEs)**

## IX Distance of Stars

**A) Parallax**

1. Arcsecond

**b)** Parsec

## X To determine Luminosity of Stars

**A) Intrinsic power of stars**

1. Apparent brightness

**b)** Photometry (charged coupling device)

# B) Brightness of Stars

**a)** Brightness Scale

1. “Absolute Magnitude”

**C) Spectral Analysis**

**a)** Stefan-Boltzman Law

1. Є= σ T4

**b)**Wiens Law

1. λmT = constant (2.9 x 106 nm-K)

**D) Classification of all stars based on Surface Temperature**

**a)** Apparent Brightness

1. **4d2 =** inverse square law

**b)** Luminosity (power)

# XI Brightness of Stars

**A)** Brightness Scale

**a)** Apparent Magnitudes

**b)** Absolute Magnitude

**c)** Apparent Brightness

**B)** Stefan-Boltzman Law

**C)** Wiens Law

**XII Luminosity-Temperature-Diameter Relationship**

**A)** Hertzsprung-Russell (H-R) Diagram

**B)** Typical Stars

**C)** Principles Governing structures of Main-Sequence stars

## XIII Structure and formation of Stars

**A)** Stellar Structure Laws

**a)** Conservation of mass

**b)** Conservation of energy

**c)** Hydrostatic equilibrium

**d)** Energy transport

**B)** Stellar nuclear fusion

**C)** Red, Brown, & sub-Brown Dwarfs

**D)** Pressure-Temperature and Mass-Luminosity Relationships

**XIV Types of Nebulae**

1. Emission nebulae
2. Reflection nebulae
3. Dark nebulae

**XV Giant Stars**

**XVI Variable Stars**

**XVII White dwarfs**

**XVIII The Planets of the Inner Solar System:**

**A) Mercury**

1. Caloris Basin
2. Lobate scarps
3. Gravitational resonance
   1. **Venus**
4. Run-Away Greenhouse Effect
5. Thick atmosphere
   1. **Earth**
6. Standard of comparative planetology
7. Geologically active

* 1. **Mars**

1. Moons

1.Phobos

2. Diemos

**E)** **Asteroid Belt**

**a)** Kirkwood’s Gaps

## XVIX The Planets of the outer Solar System

**A) Jupiter**

**a)** Gallilean moons of Jupiter

* + - 1. Io
      2. Europa
      3. Ganymede
      4. Callisto

## XVIX The Planets of the outer Solar System

# B) Saturn

**a)** rings of Saturn are billions of ice crystals

**b)** Cassini’s Divisions

1. Ring A – Outmost ring

2. Ring B – Middle ring

3. Ring C – Inner ring

**c)** Moons of Saturn

* + 1. Over 12 moons
    2. Outermost moons have co-orbits

**C) Uranus**

1. High in methane
2. rings of Uranus
3. Moons of Uranus

5 moons

1. Miranda

2. Ariel

3. Umbriel

4. Titania

5. Oberon

# 

# D) Neptune

1. Neptune’s atmosphere
2. Rings of Neptune
3. Neptunes Moons

Triton & Nereid