Astronomy 101: The Solar System
Course Outline

Chapter 1: Overview and Scale of the Universe

- Math review
  - Powers of 10
  - Scientific notation
  - Units of measurement
  - Light year
- Size and scale of the Universe
- Age of the Universe
- Origin of elements in the cores of stars
- Expansion of the Universe
- Motion of the Earth & Sun

Chapter 2: Observing the Sky and the Celestial Sphere

- The Solar System, star clusters, galaxies
- The Scientific Method
- Constellations
- The Celestial Sphere
- Diurnal (daily) motion & impact on observing the sky
- Annual motion & impact on observing the sky
- Angles & angular measurements
  - Prevalence in astronomy
  - Units of angle measurement
  - Angular diameter vs. linear diameter
- The Milky Way
- The *Local* sky
  - Altitude & azimuth
  - Latitude & longitude

- Altitude of Polaris (the "North Star"): a navigation tool!
- Celestial motions & cycles of our lives
  - The definition of days, weeks, months, & years have astronomical origins
- Phases of the Moon & motion of the Moon
- Solar & lunar eclipses
  - Cause of eclipses
  - Types of eclipses
  - Reasons that eclipses are rarely viewed
- The seasons on Earth
  - Cause of the seasons
  - Solstices & equinoxes
- Reason Venus & Mercury are "evening (or morning) stars"
- Retrograde motion of the planets

Chapter 3: Astronomy Through the Ages

- Achievements and motivations of ancient cultures in astronomy
  - Stonehenge, Mayan astronomy, Anasazi astronomy
  - Agricultural & religious purposes
- Greek astronomical concepts & achievements
  - Logical arguments of the Greek philosophers
  - Features of the Ptolemaic model of the Solar System
  - Flaws of the Greek model
- Parallax
- Copernicus, Brahe, Kepler, & Galileo
- Kepler's Laws

- Galileo's observations and arguments against the Greek model

Chapter 4: Energy & Matter

- Using proportionalities
- Basic types of energy
- Conservation of energy
- Kinetic energy
- Potential energy (e.g., gravitational, chemical)
- Thermal energy
    - Heat vs. temperature
    - Temperature scales
- Phases and properties of matter
    - Solid, liquid, gas, and "plasma"
    - Electric charge
- Properties of atoms
    - Electrons, protons, & neutrons
    - Atomic number & atomic mass number (also known as atomic weight)
    - Isotopes
    - Ions
    - Molecules
    - Energy levels
- Matter-energy: $E = mc^2$
    - Two types of nuclear reactions: fission & fusion

Chapter 5: Laws of Motion

- Four fundamental forces of nature
- Speed, velocity, & acceleration
- Scalar vs. vector quantities
- Acceleration due to gravity
- Momentum & Force
- Conservation of momentum

- Mass vs. weight
- Newton's laws of motion
- Newton's universal law of gravitation
- Angular quantities, e.g., angular momentum & torque
- Conservation of angular momentum
- Orbital motion
    - Balance of orbital velocity vs. gravity
    - Escape velocity
    - Types of orbits
    - Orbital energy & orbital encounters
- Kepler's laws as explained by Newton
- Tides
    - Tides on Earth
    - Tidal friction
    - Synchronous rotation
    - Examples of tidal effects throughout the Solar System

Chapter 6: Light

- Light carries energy & information
- Basic characteristics
    - Wavelength, frequency, energy, speed
- Dual nature
    - Particle-like characteristics
    - Wave-like characteristics
- The electromagnetic spectrum
    - Types of light
    - White light
- Interaction of light & matter
- Spectroscopy
    - Emission vs. absorption vs. continuum spectra
- Thermal radiation

- Sound waves vs. light waves
- The Doppler effect

Chapter 8: Observations of the Solar System

- Layout & observed motions
- Terrestrial vs. jovian planets
- Asteroids & comets
    - Characteristics
    - Distribution in the Solar System (asteroid belt, Kuiper Belt, Oort Cloud
- Odd cases & exceptions
- Notable features of all planets

Chapter 9: Formation of the Solar System

- Key observational constraints
- Basic governing physics
    - Gravity, conservation of energy, angular momentum, & linear momentum
- Building the Solar System
    - Condensation, accretion, & planetesimal collisions
    - The "frost line"
    - Explanation of terrestrial vs. jovian planets
    - Jovian moons
    - Solar wind
    - Transfer of the Sun's angular momentum
    - Origin and distribution of the asteroids & comets
    - Explanation of exceptions
        - e.g., origin of the Moon
- Radiometric dating & age of the Solar System
    - Radioactive decay & half life
- Extrasolar planets
    - Difficulty of *direct* detection in images

- Detection by Doppler effect wobble
  - Center of mass
  - Radial velocity: period & amplitude
  - Effect of orbit inclination
- Detection by planets by transits
- Properties & puzzles for nebular theory

Chapter 10: Terrestrial world geology & interiors

- Techniques for measurement of interior properties
  - e.g., seismic waves
- Contrasting geological properties of terrestrial worlds
- Internal structure
  - Core, mantle, & crust
  - Lithosphere
- Differentiation
- Heating of terrestrial interiors
  - Accretion, differentiation, & radioactive decay
  - Period when these processes occur
- Cooling of terrestrial interiors
  - Convection, conduction, eruptions, & thermal radiation
  - Importance of planetary size
- Magnetic fields
  - Electromagnets
  - Requirements for terrestrial magnetic field
  - Earth's magnetosphere
  - Aurora ("northern lights")
- Terrestrial planet surface processes
  - Impact cratering, volcanism, tectonics, erosion
- The importance of convection & planetary size

Chapter 11: Terrestrial planet atmospheres

- Equilibrium in nature

Pressure in planetary atmospheres
    Pressure vs. weight
The atmospheres of Mercury & the Moon
The atmospheres of Venus, Earth, & Mars
Effects & benefits of an atmosphere
Power from the Sun: solar luminosity & flux (see section 16.2 in text)
Absorption of light by molecules
    Rotational & vibrational energy
The Greenhouse effect
Equilibrium surface temperature
    Distance from the Sun
    Overall reflectivity
    Greenhouse effect
Structure of the Earth's atmosphere
    Troposphere, stratosphere, thermosphere, & exosphere
    The ozone layer & pollution
The reason the sky is blue & sunsets are red
Long-term climate change factors
    Solar brightness & habitable zone
    Rotation axis tilt
    Greenhouse effect
    Planetary reflectivity
Meteors & meteorites
Catastrophic collisions & mass extinction
Near-earth asteroids: understanding the threat & astronomical programs to find near-earth asteroids
Sources & losses of atmospheric gases, and the Evolution of terrestrial planet atmospheres