PH 2520: INTRODUCTION TO ASTROPHYSICS Instructor: Dr. Rudra Kafle

Course outline (from WPI undergraduate course catalog): A selective study of components of the universe (the solar system, stars, nebulae, galaxies) and of cosmology, based on astronomical observations analyzed and interpreted through the application of physical principles, and organized with the central purpose of presenting the latest understanding of the nature and evolution of the universe. Some topics to be covered include the Big Bang & Inflation; Stellar Behavior & Evolution; White Dwarfs, Neutron Stars, & Supernovae; Black Holes; Dark Matter & Dark Energy.

This course will be offered in academic years ending in even numbers. It will also be offered online synchronously/asynchronously in Summer E2. Please contact Dr. Rudra Kafle (rpk101@wpi.edu) for any questions.

Category II: (offered at least every other Year)

Units: 1/3

Recommended background: PH 1110 (or PH 1111), PH 1120 (or PH 1121), and especially PH 1130.

Suggested background: PH 1140.

Textbook: Foundations of Astrophysics by Barbara Ryden and Bradley M. Peterson, 2010 Pearson Education, Inc. We will be covering the material selectively from Ch. 13 - Ch. 24. Please see the next page for details.
I will also post my pdf notes and video supplements (online videos made by experts/ professionals) on the Canvas course website.
Course web page: Visit Canvas Course Website for announcements, lecture notes, assignments, and more.

Instructor: Dr. Rudra Kafle with coordinates (508-831-5392, rpk101@wpi.edu, OH-215). Please use the second coordinate to make an appointment. During the regular academic year, the classes will be held in Olin Hall 223 on Mondays, Tuesdays, Thursdays and Fridays from 12: 00 -12: 50 P.M. US Eastern Time. In Summer E2, the course will be taught synchronously/asynchronously on Zoom.
Office Hours: We will decide on the first meeting of the Term.

Grade: Your course grade will be determined as follows:

(1) Exams: 40% (Mid-Term: 20% and Final: 20%)

(2) Homework: 25%

(3) Video quizzes: 10%

(4) Project: 25% (Paper: 15% and Presentation: 10%)

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Exams: There will be TWO exams on the days specified on the Day-by-Day schedule. Each exam is of 50 minutes duration. If you have special needs and require additional time to complete your exam, make arrangements with the instructor (see Special Needs below). If unforeseen circumstances cause you to miss a scheduled exam, you can arrange with the instructor to take a make-up exam.

Homework: Along with material presented in lectures, homework assignments and video quizzes prepare you for the exams.
Homework questions/problems are
(i) selected from the End-of-the-Chapter Problems of the textbook and
(ii) designed from the *AstroUNL* and *ClassAction* software packages.
Please see the instructions for downloading and installing the software packages in Canvas Course Website under 'Homework' module. Keep pace with homework due dates and seek help sooner if you get stuck. Solutions are posted after the homework due date. Homework received after the solution is posted will not receive any credit. For full credit, write legibly and show all of your work. If you can submit a typed solution, that's even better!
Project: Choose a topic of your interest in Astronomy/Astrophysics, review the literature associated with the topic, and write a short paper on it. In the paper, perform calculations, tabulate relevant data, and include diagrams and graphs. Cite all sources. When you cite a source include the page number. For web pages, specify the sub-page so that I can find the source. You will present your paper on the day(s) specified in the Day-by-Day schedule.
Special Needs: If you need special accommodations because of a disability, or if you have medical information to share with us, please make an appointment with Prof. Kafle as soon as possible, and/or contact the Office of Accessibility Services (OAS) at (508) 831-4908 (E-mail: accessibilityservices@wpi.edu) to ensure that accommodations are implemented in a timely fashion. The OAS is located in Unity Hall (the brand-new building close to WPI Gordon Library).
Academic Integrity at WPI: Since much of the conduct of this course depends on your abiding by the WPI Academic Honesty Policy, it is important that you review this policy in the following link: www.wpi.edu/about/policies/academic-integrity.

If there are any questions about how this applies on this course, don't hesitate to ask. You can consult any authentic resources, including AI tools, available to you that aid in your understanding of the material, but you are required to write and submit your own work with properly cited references (wherever needed) for grading.

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Learn Astrophysics with Fun!

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"Astronomy compels the soul to look upwards and leads us from this world to another." - Plato

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Learning Outcomes

After completion of the course, students will be able to do the following:

(1) Calculate the apparent and absolute magnitudes of stars, their distance moduli, their luminosities, and fluxes.
(2) Obtain the equation for hydrostatic equilibrium and estimate the central pressure of stars. Explain the Hertzsprung-Russell diagrams.
(3) Explain the thermonuclear fusion in the core of the stars and calculate the energy released in a proton-proton cycle.
(4) Explain the existence of interstellar dust and gas, and the evidence for their existence.
(5) Explain the formation and evolution of stars, and derive the Jeans Radius and Jeans Mass.
(6) Explain the stellar remnants: White Dwarfs, Neutron Stars, and Black Holes. Also, explain the novae and the supernovae.
(7) Explain the morphology, kinematics, and dynamics of our galaxy. Also, explain the nucleus of our galaxy, and estimate the mass of a supermassive black hole at the center of the Milky Way galaxy.
(8) Classify the galaxies morphologically, explain cosmological distance ladder, the supermassive black holes in galaxies, and the Hubble's law.
(9) Explain active galaxies, accretion by supermassive black holes, the energetics, the Eddington limit and Eddington ratio, and the accretion disks.
(10) Explain the large-scale structure of the universe: Group, Clusters, and Super clusters.
(11) Explain Newtonian and Einsteinian Cosmology. Derive the Friedmann Equation from Newton's laws. Compare this with the relativistic Friedmann equation.
(12) Describe the consensus model of the universe, accelerating universe, and the early universe.