UMBC UGC New Course Request: PHYS406 Extragalactic Astrophysics

Date Submitted: December 30, 2017 Proposed Effective Date: Fall 2018

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COURSE INFORMATION:

Course Number(s)	PHYS406
Formal Title	Extragalactic Astrophysics
Transcript Title (≤30c)	Extragalactic Astrophysics
Recommended Course Preparation	
Prerequisite **NOTE:** Unless otherwise indicated, a prerequisite is assumed to be passed with a "D" or better.	PHYS324 with a C or better
# of Credits Must adhere to the UMBC Credit Hour Policy	3
Repeatable for additional credit?	☐ Yes ☒ No
Max. Total Credits	3 This should be equal to the number of credits for courses that cannot be repeated for credit. For courses that may be repeated for credit, enter the maximum total number of credits a student can receive from this course. E.g., enter 6 credits for a 3 credit course that may be taken a second time for credit, but not for a third time. Please note that this does NOT refer to how many times a class may be retaken for a higher grade.
Grading Method(s)	☒ Reg (A-F) ☒ Audit ☐ Pass-Fail

PROPOSED CATALOG DESCRIPTION (Approximately 75 words in length. Please use full sentences.):
An overview of extragalactic astrophysics. Particular topics include the structure and kinematics of our own galaxy, including the galactic center, the morphological classification scheme for galaxies, the evolution of elliptical and spiral galaxies, the creation and effects of supermassive black holes in the center of galaxies, gravitational lensing due to galaxies and galaxy clusters, the high-redshift Universe, and the study of dark matter and its effect on galaxy and cluster dynamics.

RATIONALE FOR NEW COURSE:
We are proposing to split the previously taught course PHYS 416, Extragalactic Astronomy and Cosmology into two courses. These are: this new course PHYS 406 Extragalactic Astrophysics, and the changed course PHYS 416 Cosmology. We have found that the present PHYS 416 course has dwelled on the topics within cosmology, and thus a separate course on extragalactic astrophysics is needed. Within the topic of astrophysics, extragalactic astronomy is one of the major branches, covering many topics, including the basic history of the Universe, the growth of structure, galaxy formation and evolution, active galaxies, star formation in galaxies, clusters and the intergalactic medium. Many of these topics are rapidly-evolving fields of active study with major discoveries happening every year, especially as new state-of-the-art observatories are coming online. Typically, if a department were to only offer two astrophysics courses, one of these would be Extragalactic Astronomy (the other being PHYS 405: Stellar Astrophysics – the number PHYS 406 was chosen to make this an appropriately numbered pair.).

EXTRAGALACTIC ASTROPHYSICS (PHYS 406)

SYLLABUS SPRING 2019

Instructor: Dr. Markos Georganopoulos
(Physics Room 409, georgano@umbc.edu, tel:410-455-8149)
Time and Location: M/W/F 2:00 - 2:50 PM in PHYS 221
Office Hours: W/F 10:00 -11:30 AM in PHYS 415
Class web page: http://astro.umbc.edu/~astromarkos/406_spring_2019
Textbook: Peter Schneider, Extragalactic Astronomy and Cosmology

Course Overview: We will start by introducing basic notions of stellar astrophysics. We will then shift to the study of our galaxy and from that to the classification scheme of elliptical and spiral galaxies and to the scaling relations between observed properties of galaxies. Next we will proceed to study active galaxies that are characterized by an accreting supermassive black hole in their center, and how these are unified. We will then move to the study of galaxy clusters and their dark-matter dominated dynamics, along with their X-ray properties and the scaling relations for cluster of galaxies. Also, we will discuss the high redshift universe, and the properties of galaxies at high redshift. If time permits, we will close with a study of galaxy evolution, including the importance of re-ionization and galaxy formation.

Learning Goals: Through examination of known phenomena, students will learn to apply astrophysics methods to extragalactic observations and model the known universe.

Resources: We will rely on the required textbook Extragalactic Astronomy and Cosmology by Peter Schneider. Additional material will be provided through notes. The class web page will be the announcement board of the course, where notes, homework, and announcements will be posted. You are expected to monitor the contents of the course web page for course assignments, schedule changes, and other course material.

Approximate weekly plan:

Week 1 (appendices 1,2, chapter 1): Basic astrophysics notions, stellar physics, tools of extragalactic astronomy

Week 2 (Chapter 2.1-2.4): Distance measurements within our galaxy, galactic structure, galaxy Kinematics

Week 3: (Chapter2.5-2.6) Galactic gravitational microlensing, the galactic center

Week 4: (Chapter 3.1-3.3) Galaxy classification, spiral and elliptical galaxies

Week 5 (Chapter 3.4-3.7): Scaling relations, population synthesis models, chemical evolution of galaxies

Week 6 (Chapter 3.8-3.11): Black holes in the center of galaxies, extragalactic distance scale, luminosity functions, galaxies as gravitational lenses

Week 7 (Chapter 5.1-5.3): AGN fundamental properties, classification, central engine

Week 8 (Chapter 5.4-5.7): Components of AGN, unified models, properties of the AGN population

Week 9 (Chapter 6.1-6.3): Local group of galaxies, optical searches for clusters, light distribution and cluster dynamics

Week 10 (Chapter 6.4-6.6): Hot gas in galaxy clusters, cluster scaling relations, cluster gravitational redshift

Week 11 (Chapter 6.7-6.8, 9.1): Galaxy population in clusters, cluster evolution, galaxies at high redshift

Week 12 (Chapter 9.2-9.4): Deep views of the universe, New types of galaxies, properties of galaxies at high redshift

Week 13 (Chapter 9.5-9.6, 10.1-10.3): Astrophysical background radiation, cosmic star formation history, reionization of the universe

Week 14 (Chapter 10.4-10.7): Galaxy formation, galaxy evolution, future outlook

It is envisioned that you will spend 6-8 hours per week on reading and examining the reading material, reviewing the class material, and completing the weekly homework assignments.

Grading:
There will be a midterm and a final exam, along with a set of homework problems each week. Your final grade will be determined by a numerical score, calculated as follows:

Class participation: 5 points
Homework: 35 points
Mid-term exam: 25 points
Final exam: 35 points

To convert the numerical score to a letter grade, I will first calculate the average numerical score of the top 10% of the students in the class. This will be the benchmark for determining letter grades as follows:

A: >90% of the benchmark
B: 80-89% of the benchmark
C: 70-80% of the benchmark
D: 50-69% of the benchmark
F: <50% of the benchmark

Class participation (5 points total): Participation, through asking questions and responding to the questions asked by the instructor is required. A thorough examination of the reading assignment is necessary for proper participation in the class. The participation grade, assigned by the instructor for each student at the end of the semester will range from zero (no participation) to five points (exceptional participation).

Homework (35 points total): Most homework questions will provide good practice for the types of questions likely to be posed in the mid-term and final exams. Also, some of the homework assigned will be used to examine complicated situations based on the class material. A homework will be assigned every week, and your lowest homework grade will be dropped in determining the homework portion of your grade.

Mid-term Exam (25 points): The mid term will cover the material from the beginning of the class up to the lecture before the first mid term. The mid-term exam will be near the middle of the semester, and they day will be announced in class at least a week in advance of the exam.

Final Exam (35 points): An exam at the end of the course on all the course material. The date of the final exam is set by the Registrar.

The questions in the homework and in the exams will be a mixture of qualitative, analytical, and numerical questions. Clear handwriting, proper English grammar and syntax, as well as logical flow of your arguments and no major missing steps are required in all exams and homework.

Please let me know in advance if you cannot participate in any of the exams due to religious or personal or any other reasons.

Academic Integrity: By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, and the UMBC Policies section of the UMBC Directory.