Proposal for a New Course

NOTE: (1) All gray text boxes must be completed (even if you just put N/A into them), otherwise the committee must consider the form incomplete.
NOTE: (2) If the new course is to be accepted as fulfilling General Education requirements, a separate approval must be done through the General Education Committee.

Contact person George Chartas Email address chartasg@cofc.edu Phone 3-3609

1. Department: Physics and Astronomy

2. Course number and title: ASTR.410: Black Holes; Advance Topics
   Number of Credits: 1   Total hrs/week: 1
   Lecture: ☒   Lab: ☐   Recitation: ☐   Seminar: ☐

   For Independent study courses:
   Research: ☐   Field experience: ☐
   Clinical Practice: ☐   Internship: ☐
   Practicum: ☐   Independent Course Work: ☐

3. Semester and year when course will first be offered:
   Spring 2013

4. Catalog Description (please limit to 50 words):
   An augmentation of ASTR.210 requiring calculus and computation. Research topics include using relativity (to explain quasar gravitational lensing, effects of general relativity on GPS satellites, and frame dragging with Gravity Probe B), calculating accretion disk emission spectra, and constraining environments and properties of black holes inhabiting active galactic nuclei.

5. CIP Code: 40.02 (This code must be determined for new courses. The codes can be found at http://nces.ed.gov/ipeds/cipcode/. If you are not sure what code to use, please consult with the Institutional Research).

6. Check if appropriate: ☐
   This course will be cross listed with:
   Rationale for cross listing:
   Please attach letters of support from the chairs of each department indicating that the department has discussed the proposal and supports it.

7. a) Could another department or program also be a logical originator of this course (i.e. History of American Education could originate in both the Teacher Education and the History departments)? If yes, what department/program? Please contact the department chair/program director and request a note or email that they are aware of the proposed new course and include that note with the proposal.
   No.
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b) Please explain overlap with any existing courses.
This course expands upon selected topics from ASTR.130 and ASTR.210, but is taught using elementary calculus and a stronger physics base. Students taking this course must also take ASTR.210 to gain an appropriate perspective of the subject material.

8. Prerequisites (or other restrictions):
Prerequisites: PHYS.112 or permission of instructor.
Corequisites: ASTR.210

9. Rationale/justification for course (consider the following issues):

 a) What are the goals and objectives of the course?
The goals and objectives of Astro 410 are to introduce students to several special topics related to black holes and their environments. Students will learn how to analyze and interpret data collected from recent observations of objects that harbor black holes, and perform numerical and theoretical calculations to estimate the observed properties of black holes.

 b) How does the course support the mission statement of the department and the organizing principles of the major?
Black holes are of central interest to modern astrophysics: they are energy sources and mass sinks behind objects responsible for active galactic nuclei, galaxy and galaxy cluster morphology, and gamma-ray bursts. A specialized course on black holes enhances the astrophysics B.S. program, while the one credit devoted to the subject insures that students will not use the elective to replacing the required courses they need to prepare for graduate school.

10. a) For courses in the major, how does the course enhance the beginning, middle, or end of the major?
This course serves as an elective that counts toward the B.A. Astronomy degree and toward the B.S. Astrophysics degree. It enhances the middle of both these programs by requiring only a moderate amount of math and physics as prerequisites.

 b) For courses used by non-majors, how does the course support the liberal arts tradition including linkages with other disciplines:

11. Method of teaching:
Lecture, working together in groups.

12. a) Address potential enrollment pattern shifts in the department or college-wide related to the offering of this course:
There will be some interest by physics and astronomy B.A. and B.S. students. However,
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the limited number of credits received for the course will not significantly impact student enrollments.

b) Address potential shifts in staffing of the department as it relates to the offering of this course:
none.

c) Frequency of offering:
  each fall: ☐  each spring: ☐
  every two years: ☒  every three years: ☐
  other ☐ (Explain):

13. Requirements for additional resources made necessary by this course:

  a) Staff:
      This course and ASTR.210 replace a special topics course in Cosmology that was previously offered in its place.

  b) Budget:
      None

  c) Library:

14. Is this course to be added to the Degree Requirements of a Major, Minor, Concentration or List of Approved Electives?
  a) ☒ yes  ☐ no

  b) If yes, complete the Change Degree Requirements form(s) and list the name(s) of the major, minor, concentration and/or list of approved electives here:
      B.S. Astrophysics
      B.A. Astronomy
      Minor Astronomy

15. Paste syllabus, reading lists, or any additional documentation that can help the committee evaluate this proposal (a syllabus is mandatory).
Proposal for a New Course

16. Signature of Department Chair or Program Director:

______________________________________________________________

Date: __________________________

17. Signature of Dean of School:

______________________________________________________________

Date: __________________________

18. Signature of Provost:

______________________________________________________________

Date: __________________________

19. Signature of Curriculum Committee Chair

______________________________________________________________

Date: __________________________

20. Signature of Faculty Senate Secretary:

______________________________________________________________

Date Approved by Senate: __________________________

Completed form should be sent by the Faculty Senate Secretary to the Registrar. After implementation, information concerning the passed course and program changes will be provided by the Registrar to all faculty and staff on campus.
Astronomy 410: Black Holes; Advanced Topics

Lecture: Tuesday  
Location: Rita Hollings Science Center, room 126  
Time: T 3:00 – 3:50 PM

Instructor: Dr. George Chartas  
Office: 129 RHSC  
Office hours: MWF () - () pm  
Phone: (843) 953-3609  
Email: chartasg@cofc.edu

A preliminary outline of the course can be found at the SCHEDULE website. Some of this material is subject to change and this site will be constantly up-dated so please check it before each class.

Syllabus

Required materials:

The required textbook for the course is Gravity’s Fatal Attraction, Black Holes in the Universe Second Edition by Mitchell Begelman and Martin Rees.

Recommended textbook for the course is Black Holes and Time Warps, Einstein’s Outrageous Legacy by Kip S. Thorne

Lecture notes and copies of relevant articles will be provided.
Course Objectives:

Students will be introduced to several special topics related to black holes and their environments. They will learn to analyze and interpret data collected from recent observations of objects that harbor black holes, and perform numerical and theoretical calculations to estimate the observed properties of black holes.

Each student will work on a research project related to an advanced topic on black holes. Students may select a topic from a list of recommended ones or propose one to the instructor.

Students working on these research projects will require some computer programming and data analysis skills, calculus, a solid knowledge of introductory level physics and an overview of black hole physics provided in the co-requisite course ASTRO 210.

ASTRO 210 covers the strange predicted properties of black holes and their environments and a brief overview and introduction to the advanced topics of ASTRO 410 without the use of any advanced mathematics and without any thorough description of the underlying physical theories.

The ASTRO 410 lectures will provide a deeper description of the theories relevant to the advanced topics than the ones provided in ASTRO 210, cover mathematical derivations related to these theories and include an overview of the current computational, theoretical and observational research studies related to these topics.
Here is a brief list of several advanced topics that will be covered.

1. Special Relativity (Lorentz transformations, relativistic velocity transformations, relativistic beaming, time dilation, length contraction), Doppler shift of light, Cosmological redshift, metrics in space-time, proper time and proper length)

2. General Relativity (equivalence principle, gravitational time dilation, gravitational redshift, curvature of space, metrics in GR, worldlines, geodesics, Schwarzschild and Kerr metrics of black holes, Einstein tensor, energy stress-tensor, tests of GR)

3. Black Hole and Host Galaxy Mass Estimates
(Black-hole mass estimates in spectroscopic binaries, determining black-hole masses in AGN, determining lens mass from gravitational lensing)

4. AGN Accretion Disks
(Accretion Efficiency, Eddington Luminosity, Bondi-Hoyle Accretion, temperature profiles and spectra of AGN accretion disks, analyzing the spectra of black-hole disks to constrain their mass and spin)

5. Frame Dragging
(Lenses-Thirring precession, The Geodetic effect (missing inch), gravitomagnetic analogy of General Relativity and electromagnetism, experimental tests of frame dragging, frame dragging near a Kerr black hole)

6. Quantum Black Holes
(Mini-black holes, black-hole entropy and Hawking radiation, evaporating black holes, primodial black holes, laboratory produced mini-black holes)
7. Gravitational waves
(indirect evidence of gravitational waves, calculation of the precession rate of a binary star, experiments to directly measure gravitational waves, Simulations of collisions between black holes)

8. Wormholes
(Einstein-Rosen bridges, Traversable wormholes, time travel)

**CREDIT:** This is a one-credit course.

**PREREQUISITES:** This course is designed for science majors. Prerequisite is PHYS.112 and corequisite is ASTRO.210.

**PROJECT/PRESENTATION:** Every student will be expected to complete a research project on a special topic related to material covered in the course. A report describing the results of this project will be due near the end of the semester.

Students are expected to present their research project to the class. The presentation may be in PowerPoint, Keynote, overhead or blackboard. It should include a list of references. There will be a date near the end of the semester allocated to these research presentations.

**Grades**

Your final grade will be calculated as follows:
Your number grade will be converted into a letter grade as follows.

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Special Needs

If you have any special needs or disabilities that might require special arrangements to be made for any aspect of this course, please let me know at the beginning of the semester or as soon as you become aware of them.

Class Policies:

Cellular technology: Please respect your classmates and keep your cellular devices off.

Cheating:
Violations of the College of Charleston Honor Code (including cheating or attempted cheating) will be referred to the Office of Student Affairs for adjudication. Examples of cheating include copying test or quiz answers, using cellular technology to communicate information during a test or quiz, copying homework answers verbatim from an external source.