Course Approval Form

For approval of new courses and deletions or modifications to an existing course.

registrar.gmu.edu/facultystaff/curriculum

Action Requested:

- [x] Create new course
- [ ] Delete existing course
- [ ] Modify existing course (check all that apply)
  - [ ] Title
  - [ ] Credits
  - [ ] Repeat Status
  - [ ] Grade Type
  - [ ] Prereq/coreq
  - [ ] Schedule Type
  - [ ] Restrictions
  - [ ] Other: _____

Course Level:

- [ ] Undergraduate
- [x] Graduate

College/School: COS **Department:** SPACS

Submitted by: Phil Rubin **Ext:** 3815 **Email:** prubin@gmu.edu

Subject Code: PHYS **Number:** 628

(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

Effective Term:

- [ ] Fall
- [x] Spring
- [ ] Summer

Year: 2015

Title:

Current: _____

Banner (30 characters max including spaces): Relativity

New: Relativity

Credits: (check one)

- [X] Fixed: 3 or
- [ ] Variable: to

Repeat Status: (check one)

- [x] Not Repeatable (NR)
- [ ] Repeatable within degree (RD)
- [ ] Repeatable within term (RT)

Maximum credits allowed: _____

Grade Mode: (check one)

- [x] Regular (A, B, C, etc.)
- [ ] Satisfactory/No Credit
- [ ] Special (A, B C, etc. +IP)

Schedule Type Code(s): (check all that apply)

- [x] Lecture (LEC)
- [ ] Lab (LAB)
- [ ] Recitation (RCT)
- [ ] Internship (INT)
- [ ] Independent Study (IND)
- [ ] Seminar (SEM)
- [ ] Studio (STU)

Prerequisite(s): PHYS 303, 305, or equivalent

Corequisite(s):

Instructional Mode:

- [x] 100% face-to-face
- [ ] Hybrid: ≤ 50% electronically delivered
- [ ] 100% electronically delivered

Special Instructions: (list restrictions for major, college, or degree;hard-coding; etc.)

Are there equivalent course(s)?

- [x] Yes
- [ ] No

If yes, please list PHYS 428

Catalog Copy for NEW Courses Only (Consult University Catalog for models)

Description (No more than 60 words, use verb phrases and present tense)	**Notes** (List additional information for the course)
Special relativity; four-dimensional space-time; general relativity; non-Euclidean geometries, geodesics, and field equations; tests of general theory of relativity; black holes; cosmology; models of the universe; remnant blackbody radiation; big bang cosmology; thermodynamics; and the universe.	

Indicate number of contact hours: Hours of Lecture or Seminar per week: 3 Hours of Lab or Studio: 0

When Offered: (check all that apply) [X] Fall [ ] Summer [x] Spring

Approval Signatures

Department Approval Date

College/School Approval Date

If this course includes subject matter currently dealt with by any other units, the originating department must circulate this proposal for review by those units and obtain the necessary signatures prior to submission. Failure to do so will delay action on this proposal.

Unit Name	Unit Approval Name	Unit Approver's Signature	Date

For Graduate Courses Only

Graduate Council Member

Provost Office

Graduate Council Approval Date

For Registrar Office's Use Only: Banner_____ Catalog_____

revised 2/2/10

Course Proposal Submitted to the Curriculum Committee of the College of Science

1. COURSE NUMBER AND TITLE: PHYS 628 Relativity

Course Prerequisites: PHYS 303 and 305, or equivalent

Catalog Description: Special relativity; four-dimensional space-time; general relativity; non-Euclidean geometries, geodesics, and field equations; tests of general theory of relativity; black holes; cosmology; models of the universe; remnant blackbody radiation; big bang cosmology; thermodynamics; and the universe.

2. COURSE JUSTIFICATION: Now listed as an Astronomy course, which is being deleted; it is a physics course; physics, at present, has no graduate-level relativity course.

Course Objectives: To study special, general, and cosmological relativity.

Course Necessity: Physics, at present, has no graduate-level relativity course.

Course Relationship to Existing Programs: Relativity is an integral field of knowledge in physics, but no graduate-level physics course on relativity now exists.

Course Relationship to Existing Courses: Equivalent to the undergraduate PHYS 428

3. APPROVAL HISTORY:

4. SCHEDULING AND PROPOSED INSTRUCTORS:

Semester of Initial Offering: Spring 2015

Proposed Instructors: Weingartner, Oerter

5. TENTATIVE SYLLABUS: See attached.

PHYS 428/628: Relativity

Lectures

Place: ST I, room 206
Time: Tuesday, Thursday 12:00–1:15 pm
Lecture notes on the web at www.physics.gmu.edu/∼joe/PHYS428.html

Instructor

Joe Weingartner (call me Joe)
Science and Technology I, room 317
jweinga1@gmu.edu
Office hours: Wednesday 3:00–4:00 pm, Thursday 1:30–2:30 pm, or by appointment

Course Textbook

Relativity: *Special, General, and Cosmological*, 2nd ed, W. Rindler (Oxford University Press)

Recommended Supplemental Text

Introduction to Electrodynamics, 3rd ed, D. J. Griffiths (Prentice Hall)

Evaluation

Homework (60%)
1. You are encouraged to discuss the problems with one another, but the detailed solutions that you submit must be your own, independent work.
2. Do not hesitate to seek help from me, in person, over the phone, or by email.
3. The point value of each problem is indicated in brackets. Tentatively, the total number of points for the semester will be 635 for PHYS 428 and 785 for PHYS 628.
4. Homework will be due at the start of class on the announced dates. Late homework will only be accepted in extenuating circumstances.
5. The clarity of your solutions will factor significantly into your grade. It is not sufficient to write a few equations. You must define your variables, draw well labeled figures where appropriate, and explain what you're doing. Use the distributed solutions to sample problems and homework problems as a guide for the level of detail required. Also, you must write legibly. I will not struggle to decipher handwriting; instead, I will simply assign zero points.
6. Each week, I will choose a fraction (possibly 100%) of the submitted problems to grade. Of course, I will not reveal in advance which problems will be graded. Your total earned points for each submission will be AB/C, where C is the total number of points in the graded problems, A is the number of points you earned on those problems, and B is the total number of points in the problems on which you made a serious effort.
7. Unless explicitly stated, you may not use computer programs like Mathematica.
8. When a problem asks you to "show" something, this should be interpreted as "derive" rather than "verify".
9. Problem sets for PHYS 628 are longer than those for PHYS 428. The additional problems are more mathematically challenging and probe the physics to greater depth.

2 in-class exams (10% each)
Exam 1 will cover Topics 1–4 and is tentatively scheduled for March 1.
Exam 2 will cover Topics 5–8 and is tentatively scheduled for April 12.

Final exam (20%)
This will be held on May 15, 10:30am–1:15pm, in the same room as class. It will cover all the course material, but Topics 9–11 will be more heavily represented than the earlier material.

Letter grades for the course will be determined from total numerical grades as follows:
A range: 87-100%
B range: 74-87%
C range: 64-74%
D: 55-64%
F: $< 55\%$

Course Outline

1. Motivation for Special Relativity
2. The Foundations of Special Relativity
3. Spacetime and 4-vectors
4. Relativistic Mechanics
5. Introduction to Tensors
6. Electrodynamics
7. Introduction to General Relativity
8. Geodesics in Curved Spacetime
9. Curvature and Einstein's Field Equations
10. The Schwarzschild Metric and Applications
11. Introduction to Cosmology

Recommended Reading (by topic)

1. Rindler 1.1 through 1.10; Griffiths 1.2, 7, 12.1.1, Appendix C
2. Rindler 2.1 through 2.8, 3.1 through 3.6, 4.3; Griffiths 12.1.2 and 12.1.3
3. Rindler 5.1, 5.4 through 5.6; Griffiths 12.1.4, 12.2.1
4. Rindler Ch 6 (omit 6.5 and 6.8); Griffiths 12.2.2 through 12.2.4
5. Rindler 7.1, 7.2
6. Rindler 7.3 through 7.7; Griffiths 12.3
7. Rindler 1.11 through 1.16
8. Rindler 8.3, 8.4, 10.1 through 10.4
9. Rindler 10.5, 10.6, 14.1, 14.2
10. Rindler 11.1, 11.2, 11.5 through 11.12
11. Rindler 16.1 through 16.5 (except 16.3), 17.2, 18.1 through 18.4

Recommended Study Strategy

For each topic, lecture notes will be available on the course web site in pdf format. Before class, print out the notes and read the relevant sections in Rindler, as indicated on the course web site. At this point, you do not need to master the material in Rindler, but familiarity with it will help you to keep up with the lecture.

During the lectures, structure your own note taking around the printed course notes. The pace will be too quick for you to write down everything on your own. Focus on writing down clarifications and extra detail not contained in the printed notes.

Only part of the class time will be devoted to lectures. We will also spend a lot of time working sample problems. I'll distribute these problems, as well as detailed solutions, before class. Please print these and bring them to class. You may want to jot additional notes on them.

After class, carefully review your lecture notes and the worked problems. Reread the relevant sections of Rindler, this time making sure that you have mastered the material. Make note of anything you don't understand and ask me about it at my office or at the next class.

The homework assignments will be challenging. For many problems, you will probably need to make multiple attempts in order to achieve the full solution. For this reason, it is critical that you start working on the problem set shortly after it is assigned. Allow yourself plenty of time to seek help, both from me and from your classmates. I suggest that you form study groups and meet regularly to discuss the problems. But make sure that you've put in serious effort before meeting with your classmates!

After class, I will distribute, by email, solutions to the homework. Carefully study the solutions, regardless of how well you did on the problems. You may find that my solution differs from yours, and it can be very valuable to have the additional perspective. Redo the homework problems (and sample problems) until you can easily solve them without the use of aids (except for the formulas sheet).