Course Change Request

New Course Proposal

Date Submitted: 08/26/19 3:47 pm

Viewing: ASTR 601 : Computer Simulation in Astronomy

Last edit: 08/26/19 3:47 pm

Changes proposed by: prubin

Are you completing this form on someone else's behalf? No

Effective Term: Fall 2018

Subject Code: ASTR - Astronomy **Course Number:** 601

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Computer Simulation in Astronomy

Banner Title: Simulation in Astronomy

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable: May only be taken once for credit (NR)
GRADUATE ONLY

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s): ASTR 210, PHYS 251

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description: Techniques and methods to simulate astronomical phenomena using a computer. Examples taken from a wide variety of astronomical phenomena, including radiation transfer in astrophysical objects, self-gravitating systems, hydrodynamics, and stellar models.

In Workflow

1. **PHYS GR Committee**
2. **PHYS Chair**
3. **SC Curriculum Committee**
4. SC Associate Dean
5. Assoc Provost-Graduate
6. Registrar-Courses
7. Banner

Approval Path

1. 11/01/19 1:33 pm Ernest Barreto (ebarreto): Approved for PHYS GR Committee
2. 11/01/19 2:44 pm Paul So (paso): Approved for PHYS Chair

Justification:	Computer simulation is an essential tool in modern astrophysics. This will be an important course for the astronomy track in the physics PhD and will also be of interest to students pursuing the MS in applied and engineering.
Does this course cover material which crosses into another department?	No
Learning Outcomes:	
Attach Syllabus	syllabus-ASTR601.pdf
Additional Attachments	
Staffing:	Satyapal, Weingartner, Plavchan
Relationship to Existing Programs:	Required co-requisite for ASTR 602; cross-level listed with (already existing) ASTR 401 (therefore no additional resources required)
Relationship to Existing Courses:	Elective for the physics MS and PhD programs; highly recommended for students on astrophysics tracks

Additional Comments:	
Reviewer Comments	

Key: 15863

ASTR 601: Computer Simulation in Astronomy

Classes

Place: Exploratory Hall, room 1004
Time: TR 12:00–1:15
Web site: www.physics.gmu.edu/∼joe/ASTR401.html

Instructor

Joe Weingartner
Planetary Hall, room 231
703-993-4596
jweinga1@gmu.edu
Office hours: TR 3:00-4:00

Course Objective

Develop the skills and knowledge needed to participate in research projects in computational astronomy. Topics chosen from the gravitational N-body problem, applied to planetary systems and/or globular clusters, and Monte Carlo simulations in astronomical data analysis.

Evaluation

Coding assignments, to be worked both in class and at home (100%)

1. You are encouraged to discuss the assignments with one another, but the scripts that you submit must be your own, independent work. You may not share any electronic files, including scripts and data files, with one another.
2. Do not hesitate to seek help from me, in person or by email.
3. The point value of each problem is indicated in brackets.
4. See the course web site for due dates. Assignments are due at the start of class. Late work will not be accepted. If you don't finish the assignment, turn in what you have. If you can't make it to class on time, submit the assignment earlier.
5. 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.

Letter grades for the course will be determined from total numerical grades as follows:
A range: 90-100%
B range: 80-90%
C range: 70-80%
D: 60-70%
F: $< 60\%$

Sample Weekly Schedule

Week 1: The One-Body Problem; Analytic Solution for a Circular Orbit; Elliptical Orbits;

Kepler's Equation; Solving Kepler's Equation (Plot the Function, Bracket the Root, Bisection, The Newton-Raphson Method);

Week 2: Initial Value Problem; Constants and Units; astropy; Circular Orbit; The Euler and Euler-Cromer Methods

Week 3: Runge-Kutta Methods; Elliptical Orbit; Initial Values; Runge-Kutta with Fixed Step Size

Week 4: Adaptive Step Size

Week 5: The Bulirsch-Stoer Method; The Modified Midpoint Method; Polynomial Extrapolation

Week 6: The Bulirsch-Stoer Method (continued)

Week 7: Bulirsch-Stoer versus Adaptive Runge-Kutta

Week 8: The Few-Body Problem; Force Evaluations and the Evolution Function

Week 9: Center of Mass; Orbital Elements; Total Energy

Week 10: Test: The Two-Body Problem

Week 11: Test: The Restricted Circular Three-Body Problem

Week 12: The Giant Planets

Week 13: The Giant Planets (continued)

Week 14: Chaos

University Resources

Learning Services (https://learningservices.gmu.edu/)

Student Support and Advocacy Center (https://ssac.gmu.edu/)

Counseling and Psychological Services (https://caps.gmu.edu/)