Course Approval Form

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

More information is located on page 2.

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

Course Level:

- [ ] Undergraduate
- [X] Graduate

College/School: College of Science **Department:** Physics & Astronomy

Submitted by: Jessica Rosenberg **Ext:** 3-9551 **Email:** Jrosenb4@gmu.edu

Subject Code: ASTR **Number:** 602

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

Effective Term: [X] Fall [ ] Spring [ ] Summer *Year* 2011

Title: Current:
Banner (30 characters max including spaces):
New: Methods of Observational Astronomy

Credits: (check one) [3] Fixed [ ] or [ ] Variable [ ] to [ ]

Repeat Status: (check one)

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

Total repeatable 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):	**Corequisite(s):**

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

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)
Collection and analysis of data covering radio, microwave, infrared, visible, ultraviolet, X-ray, and gamma ray astronomy. Topics include electromagnetic spectrum, coordinate systems, motion of celestial objects, telescopes, detectors, statistics and noise, interferometry, and spectroscopy. The course makes extensive use of computational methods.	

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

When Offered: (check all that apply) [ ] Fall [ ] Summer [3] 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

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

1. COURSE NUMBER AND TITLE:

ASTR 602 Methods of Observational Astronomy

Course Prerequisites:

Graduate standing.

Catalog Description:

Collection and analysis of data covering radio, microwave, infrared, visible, ultraviolet, X-ray, and gamma ray astronomy. Topics include electromagnetic spectrum, coordinate systems, motion of celestial objects, telescopes, detectors, statistics and noise, interferometry, and spectroscopy. The course makes extensive use of computational methods.

2. COURSE JUSTIFICATION:

Course Objectives:

The objective is to introduce students to the fundamental skills required to pursue a career in observational astronomy. In particular the students will learn to write an observing proposal, aquire data, reduce and analyze the data and write up the results.

Course Necessity:

Observational astronomy and the techniques used to take and reduce astronomical data are critical for any graduate student working in the field, particularly if they did not have a comparable course as an undergraduate (not all undergraduate programs offer such a class). The material covered in this class is fundamental to a students ability to perform independent research.

Course Relationship to Existing Programs:

All PhD students concentrating in astronomy/astrophysics will take this course. The course will be offered every other year. Assuming 3 to 5 graduate students per year concentrating in astrophysics, we expect an enrollment of 6 to 10 students. By setting the course at the 6xx level, we retain the possibility of offering it in conjunction with ASTR 402, which is required for all undergraduate astronomy majors.

Course Relationship to Existing Courses:

There are no similar courses at the graduate level.

3. APPROVAL HISTORY:

4. SCHEDULING AND PROPOSED INSTRUCTORS:

Semester of Initial Offering:

Fall Semester, 2011 – offered in alternate spring semesters.

Proposed Instructors:

Rosenberg, Geller, Satyapal, Gliozzi

5. TENTATIVE SYLLABUS: See below.

Astronomy 602: Methods of Observational Astronomy
Syllabus

Course Goals:

The goal of this course is to introduce you to the observational, statistical, and computational techniques used by observational astronomers. The course is designed to give you some of the basic skills you will need as an astronomer.

Introduction:

In order to learn about the techniques used by observational astronomers we must cover a lot of ground in this course. We will learn about telescopes and detectors, methods for taking, reducing, and analyzing data, and the statistics required for understanding the data and analysis. The course will rely heavily on the use of computers and you will be expected to become proficient in using the Linux environment and data analysis programs. **Because of the quantity and diversity of material that you will need, this class will require substantial time and effort. You must expect to invest a significant amount of time in this class to succeed.** In return for your effort, I will work hard to help you build these skills. I also hope that this class will be friendly and collaborative.

Telescopes:

Unfortunately the large campus telescope will not be installed in time for this class so you will not be able to use it for your projects. Instead we will get time on a remote telescope so that you can carry out a set of observations that you will use for your project in the class. These observations will be done in groups of 2. In addition, we will have at least 1 or 2 observing nights to allow you to learn to use the small telescopes on campus. I am also hoping (this will depend a little on timing) that we will have a chance to do at least one night of remote observing on the Arecibo radio telescope in Puerto Rico. Be aware in advance that observing does not always go as planned, weather, scheduling and instrumentation can all interfere – that is the nature of observational of work.

Computers:

The use of computers is fundamental to astronomical work so they are going to play a very important role in this class. We will use the computers located in the classroom. These computers are all running the Linux operating system with which you will become familiar if you are not already. For data reduction we will primarily use IRAF except for the section on radio data for which we will use IDL. You will also be expected to use a computer for some of the plotting and analysis of data. I will recommend IDL and will help students out using this tool (this is why an IDL book is on the recommended list). If you are already comfortable with programming and plotting in another language, you are welcome to use that instead, but I may not be able to help you with issues of syntax or with debugging code in another language.

Contact Information: Jessica Rosenberg
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phone: 703-993-9551

Office Hours: By appointment
Course web site: http://physics.gmu.edu/~jrosenb4/astronomy402.html

Course Textbook: Observational Astronomy, by Birney, Gonzalez, and Oesper Second edition
Recommended Texts:
An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement, John R. Taylor
Practical IDL Programming: Creating Effective Data Analysis and Visualization Applications, Liam E. Gumley

Grading:

Class Exercises	10%
Homework	15%
Telescope Proposal	20%
Observing project	30%
Graduate project	25%

Telescope Proposal

Ultimately for this class you are going to obtain a series of observations that you will then analyze. As astronomers we need to submit a proposal that describes the observations we are going to carry out to get time on a telescope. In this case you will write a proposal that will be evaluated by your classmates before you obtain the data for your project. This process will be very similar to the one used by professional astronomers when applying for telescope time. The format of the proposal is given below. The proposal must be at least 1000 words long. In general there are 3 important parts of every proposal:

I. Abstract the goal of the abstract is to sum up the main justification for the project. You will talk about what you are going to do and why in a paragraph.
II. Scientific Justification the scientific reason that you are going to pursue the project. What is it you are going to get out of these data in the end?
III. Technical Justification this is the most important part of the proposal for the purposes of this class. This section should be a bit more complete than it would probably be for a submitted telescope proposal. This must be written in prose (i.e., full sentences). When writing this part of the proposal, consider the following:
    a) Target source (why was this chosen rather than another),
    b) Time when the target is visible (at the time of the observations, but you can also comment on its observability during the class time – i.e., if the telescope had been available would you have been able to do this project),
    c) Length of time for which the source is visible at the telescope,
    d) Filters to be used,
    e) Number of exposures,
    f) Length of exposures,
    g) Time separation of exposures if that is relevant,
    h) Number and duration of calibration exposures and how they will be used in the data analysis,
    i) Expected S/N of the observed sources,

Project Paper

The goal of the project paper is to describe the observations, data reduction, and results of your research project. The minimum word limit for the paper is 2000 words. The format for this paper will follow the format of astronomical publications so it may be helpful for you to have a look at the Astrophysical Journal to see an example of what this format looks like. The primary components of your paper will be:

1) Abstract: an overview of what has been done and the results of your project.
2) Introduction: explains why this project is of interest and what the goals of the project are. This section will look a lot like your scientific justification section from the telescope proposal (I highly recommend that you look at any comments on your proposal justification and edit this section accordingly.
3) Data Reduction: describes the details of the data reduction you have done. This section needs to be very thorough! Discuss all of the observations you have and details including but not limited to: telescope used, types of observations take, duration of observations, step-by-step description of the data reduction procedure including all calibration, photometry, etc. Include figures where they are relevant.
4) Results: describes the results of your project. This section should be about the science that was done with the data. Use figures to illustrate your results.
5) Conclusions: a short statement of what you infer from the results noted in the previous section.
6) References: bibliography

These projects will be done in pairs, but the write-up must be your own. You will both fail the paper if what you turn in is not original. This doesn't mean that you can't talk about the work that you are doing, it means that what you submit MUST BE IN YOUR OWN WORDS! Also make sure that you are the first author on the paper and anyone else that contributed is co-author (if they did a significant amount of work like you partner is expected to have done) or is cited in the acknowledgements if they were part of a useful discussion of the work or contributed a useful idea (but not a significant part of the results).

Observing Proposal or Project

Another major part of the grade for this class is an additional observing proposal or project. My preference for this part of the class would be for you to write an observing proposal to a major telescope – either a public ground based facility or a satellite for which you can apply for time. The idea would be that you would put together a proposal that is of high enough quality both technically and scientifically, that it could be submitted for time. If you are currently working on a research project as part of your degree this proposal could be a part of that research. If you choose to do the project instead it can be an extension of the original project for the class or something completely new. You can extend the observations to compare multiple sources or you can do a thorough literature search and integrate your initial results with the larger body of literature in a way that goes well beyond that of the original paper (which means that this has to be more than the literature search that is expected in writing up your original results).

Date	Reading/Assignment due	Topic
Jan 19		Introduction, Coordinates and time VOSE
Jan 21	Chap. 1,2,4	**Exercise 1:** Introduction to Linux, IRAF, IDL
Jan 26	Chap 5, Appendix 1 Homework #1 due	Statistics
Jan 28	Exercise #1 due	**Exercise 2:** Statistics
Feb 2	Chap 8, 9 Homework #2 and Proposal outline due	CCD Detectors, dark and bias images
Feb 4	Exercise #2 due	**Exercise 3:** Dark and bias current
Feb 9	Chap 6, 7 Homework #3 due	Telescopes, flat fields and linearity
Feb 11	Exercise #3 due	**Exercise 4:** Flat field images
Feb 16	Chap 10	Photometry and image calibration (relative vs absolute photometry)
Feb 18	Exercise #4 due	**Exercise 5:** CCD processing
Feb 23	Proposals due	**Exercise 5:** CCD processing cont.
Feb 25		**Exercise 6:** Photometry
Mar 2	Chap 11 Exercise #5 due	Astrometry
Mar 4	Read Proposals	Time allocation committee meeting
Mar 16	Chap 12 Exercise #6 due	Spectroscopy
Mar 18	Chap 13	**Exercise 7:** Spectroscopy and submission of observing requests
Mar 23	Homework #4 due	**Exercise 7:** Spectroscopy continued

Mar 25		Preliminary analysis of project data
Mar 30	TBA	Infrared astronomy
Apr 1	Exercise #7 due	**Exercise 8:** Infrared data processing
Apr 6	Homework #5 due	Observing project data processing
Apr 8	TBA	High energy astronomy
Apr 13	TBA Exercise #8 due	Radio astronomy
Apr 15	Draft of paper not including conclusions due	**Exercise 9:** Radio astronomy
Apr 20		**Exercise 9:** Radio astronomy continued
Apr 22	TBA Exercise #9 due	Interferometry
Apr 27	Homework # 6 due	**Exercise 10:** interferometry
Apr 29		Final class/**Exercise 10:** interferometry continued
May 4	Exercise #10 due	
May 6	Final draft of paper is due	