## Course Approval Form

**Action Requested:**
- Create new course
- Modify existing course (check all that apply)
- Inactivate existing course
- Reinstate inactive course

**Course Level:**
- Undergraduate
- Graduate

### College/School:
- College of Science

### Department:
- Department of Physics and Astronomy

### Subject Code:
- PHYS

### Number:
- 665

### Effective Term:
- Fall
- Spring
- Year
- 2016

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- PHYS

### Number:
- 665

### Effective Term:
- Fall
- Spring
- Year
- 2016

### Title:
- Planet Atmospheres & Ionospheres

### Credits:
- Fixed
- Variable
- 3

### Repeat Status:
- Not Repeatable (NR)
- Repeatable within degree (RD)
- Repeatable within term (RT)
- Maximum credits allowed:
  - 3

### Grade Mode:
- Regular (A, B, C, etc.)
- Special (A, B, C, etc. +IP)

### Schedule Type:
- Lecture (LEC)
- Lab (LAB)
- Recitation (RCT)
- Internship (INT)
- LEC can include LAB or RCT

### Prerequisite(s):
- PHYS 262 and MATH 214

### Corequisite(s):

### Restrictions Enforced by System:
- Major, College, Degree, Program, etc. Include Code.

### Approval Signatures:
- Department Approval Date: 11/06/2015
- College/School Approval Date:

### Catalog Copy for NEW Courses Only

**Description**
An interdisciplinary introduction to the fundamental physics and chemistry of the atmosphere-ionosphere system. The focus is on the governing equations of atmospheric and ionospheric dynamics with a systems (science) approach to the atmosphere-ionosphere coupling processes. Topics include observational and modeling techniques in the Earth’s upper atmosphere as well as recent progress in planetary atmosphere-ionospheres and planetary missions.

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

**When Offered:**
- Fall
- Summer
- Spring

**Approval Signatures:**

**For Graduate Courses Only**

**Graduate Council Member**

**Provost Office**

**Graduate Council Approval Date**

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**For Registrar Office’s Use Only:**
- Banner__
- Catalog__

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*For instructions see: http://registrar.gmu.edu/facultystaff/catalog-revisions/course/*

*revised 10/16/14*
FOR ALL COURSES (required)
Course Number and Title: PHYS 665, Planetary Atmospheres and Ionospheres
Date of Departmental Approval: 11/06/2015

FOR NEW COURSES (required if creating a new course)

- Reason for the New Course:
  1) To address the need to provide a theoretical background in systems science approach in atmospheric and ionospheric physics for graduate students
  2) A demonstrated high level of interest among the graduate students in the physics and astrophysics programs.
  3) The need to provide basic conceptual knowledge and training for graduate students who are interested in atmospheric, space and planetary sciences

- Relationship to Existing Programs:

  Research efforts in atmospheric and planetary sciences are rapidly growing at Mason. Basic astrophysics and planetary science courses are offered by the astrophysics faculty. Fundamental atmospheric physics is also taught. Currently, Mason is involved in two major satellite missions related to planetary atmospheres, New Horizon (Pluto) and MAVEN (Mars). Several students and faculty members conduct research in terrestrial and planetary atmospheres. However, these fields are taught separately and a systems science course is needed that would teach graduate students the basic fluid dynamics and plasma physics of terrestrial and planetary atmospheres motivated by the planetary science missions. Also, no ionospheric physics is taught at Mason, which the proposed course will cover to a large extent. The works of some other instructional faculty (e.g. Weigel, Zhang, Summers) and research faculty (e.g., Meier, Richards) have inter-disciplinary connections to planetary atmospheres and ionospheres.

- Relationship to Existing Courses:

  A natural sequel to the atmospheric, astrophysics and space weather courses.

- Semester of Initial Offering:
  
  - Spring 2016

- Proposed Instructors:
  
  - Erdal Yiğit

- Insert Tentative Syllabus Below
  
  - Attached.

- See also the website of the course at http://yigit.onair.cc/course/planetary-atmospheres-and-ionospheres/, which will be taught as a special topics (PHYS 390/PHYS 590) course next semester (Spring 2016).
Syllabus: PHYS 465/PHYS 665 Planetary Atmospheres and Ionospheres
Spring Semester, 2016

1 Catalog description:
An interdisciplinary introduction to the fundamental physics and chemistry of the atmosphere-ionosphere system. The focus is on the governing equations of atmospheric and ionospheric dynamics with a systems (science) approach to the atmosphere-ionosphere coupling processes. Topics include observational and modeling techniques in the Earth’s upper atmosphere as well as recent progress in planetary atmospheres and ionospheres and planetary missions.

2 Introduction
This interdisciplinary course will provide a concise introduction to fundamental physical and chemical processes in the atmosphere-ionosphere system. Topics include:

- Conservation laws
- Neutral planetary atmospheres
- Wave processes
- Ion-neutral coupling
- Chemical & ionization processes
- Global modeling
- Planetary Ionospheres

3 Instructor and contact information
Erdal Yiğit
Space Weather Laboratory
Planetary Hall, Room 261
eyigit@gmu.edu
Phone: 703 993 2658

4 Specific course goals
To provide the students with:

(1.) an understanding of fundamental governing equations of planetary atmospheres and ionospheres and their application;
(2.) an overview of fundamental coupling processes in the planetary upper atmospheres;
(3.) recent progress in atmospheric and planetary science and missions.
5 Course format & activities

- **Lectures** presenting materials in the books by *Schunk and Nagy* [2009] and *Holton and Hakim* [2012];
- **Homework assignments** that help understand the material encountered in the lectures and readings;
- **Reading assignments** both from the texts and supplemental material;
- **Group discussion** to help develop further understanding of the learning material;
- **Two exams** during the semester
- **Active learning activities**

6 Required Assignments

6.1 Textbooks

The textbooks by:

(1.) *Schunk and Nagy* [2009]: Primarily a textbook that focuses on ionospheric physics and chemistry.

(2.) *Holton and Hakim* [2012]: A comprehensive book of atmospheric dynamics.

will be used. As basic literature the book by *Yiğit* [2015] is recommended as well.

Additional suggestions for reading are in section 9. The students are encouraged to follow the lectures and participate in discussions to develop a deeper understanding of the materials.

6.2 Tentative Weekly Schedule

Approximately, the following chapters will be covered weekly:

(Week 1.) Introduction to atmospheric dynamics [*Holton and Hakim*, 2012, Chpt 1]

(Week 2.) Basic conservation laws and their elementary applications [*Holton and Hakim*, 2012, Chpt 2]

(Week 3.) Basic conservation laws and their elementary applications [*Holton and Hakim*, 2012, Chpt 3]

(Week 4.) Atmospheric oscillations [*Holton and Hakim*, 2012, Chpt 5]

(Week 5.) General circulation [*Holton and Hakim*, 2012, Chpt 10]

(Week 6.) Middle atmosphere dynamics [*Holton and Hakim*, 2012, Chpt 12]

(Week 7.) Numerical modeling and prediction [*Holton and Hakim*, 2012, Chpt 13]

(Week 8.) Introduction to geospace environment [*Schunk and Nagy*, 2009, Chpts 1–2]

(Week 9.) Collisions [*Schunk and Nagy*, 2009, Chpt 4]

(Week 10.) Simplified transport equations in planetary atmospheres [*Schunk and Nagy*, 2009, Chpt 5]

(Week 11.) Chemical processes [*Schunk and Nagy*, 2009, Chpt 8]

(Week 12.) Ionization and energy exchange processes [*Schunk and Nagy*, 2009, Chpt 9]

(Week 13.) The terrestrial ionosphere [*Schunk and Nagy*, 2009, Chpts 11–12]

(Week 14.) Planetary ionospheres and current missions [*Schunk and Nagy*, 2009, Chpt 13]

(Week 15.) Ionospheric measurement techniques [*Schunk and Nagy*, 2009, Chpt 14]

Depending on the performance of the class and other issues, this list could change slightly throughout the semester.
7 Course policy and grading

7.1 Grading distribution

The final grade will result from performances in homework assignments, two exams, class participation, and term paper writing (for graduate students).

7.1.1 Undergraduate grading

<table>
<thead>
<tr>
<th>Component</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>40%</td>
</tr>
<tr>
<td>One midterm exam</td>
<td>20%</td>
</tr>
<tr>
<td>One final exam</td>
<td>30%</td>
</tr>
<tr>
<td>Participation</td>
<td>10%</td>
</tr>
<tr>
<td>Term paper</td>
<td>0%</td>
</tr>
</tbody>
</table>

7.1.2 Graduate grading

<table>
<thead>
<tr>
<th>Component</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>30%</td>
</tr>
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<td>10%</td>
</tr>
<tr>
<td>Term paper</td>
<td>30%</td>
</tr>
</tbody>
</table>

Please note that class participation is also graded.

7.2 Term paper presentation

Terms papers are due by the beginning of the last lecture of the semester.

8 Term paper

A term paper is required in this course. The goal of the paper is to study a specific research topic in detail. Below a number of topics in atmospheric, ionospheric and planetary science are suggested. The student chooses a topic, which must be approved by the instructor. The students can also choose a different topic as long as they can justify the relevance of it to the course. I am happy to guide the student to choose a topic. Student are expected to give an update every two weeks in the class on the progress of their research and writing.

8.1 Suggested term paper themes

- Atmosphere
  - Sudden Stratospheric warmings
  - Gravity waves
  - Solar tides
  - Thermospheric vertical winds
  - Gravity wave generation processes

- Ionospheres
  - Ionospheric variability and its sources
  - Joule heating
• Thermosphere-ionosphere coupling
• Geomagnetic storms and space weather
• Transport of species
• Thermosphere-ionosphere modeling

• Planetary atmospheres
  • Satellite missions to Mars
  • Rover missions on Mars
  • Dust storms on Mars
  • Planetary habitability
  • Manned mission to Mars
  • Modeling of planetary atmospheres

8.2 Term paper format

Abstract: A brief description of the paper, not to exceed 200 words.

Introduction: This section describes the historical background and context of the topic, citing the appropriate papers. Recent investigations related to the topic are summarized and the goals of the paper are clearly stated along with a brief statement of the main methodology of the research.

Main part: This part presents the main results of the investigation, putting the results in the context of published work.

Summary and Conclusions: Main results and conclusions of the paper are summarized.

References: List of cited work (American Geophysical Union style is recommended).

Format of the term paper: The paper must be typed, double-spaced, about 15–20 pages long (excluding figures), and have at least 4 figures with captions. All pages must be numbered. Use “Times” with 12pt script size. Section titles should be bold.

9 Additional recommended books

The books by Andrews et al. [1987]; Chamberlain and Hunten [1987]; Rees [1989]; Hargreaves [1992]; Batchelor [2000]; Nappo [2002]; Prölss [2004a,b]; Vallis [2006]; Moldwin [2008] can support your studies throughout this course.

10 Useful websites

Some atmospheric & space agencies:

• NASA http://nasa.gov
• ESA http://www.esa.int
• NOAA http://www.noaa.gov
Some international unions/organizations:

- COSPAR: https://cosparhq.cnes.fr/
- ICSU http://icsu.org
- IAGA http://iaga.org
- IUGG http://iugg.org
- AGU http://agu.org
- EGU http://egu.eu

11 Academic integrity

GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely.

Academic integrity essentially means when you are responsible for a task, you will perform that task yourself. When you rely on someone else’s work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. In particular, when you are writing a paper, you must give credit to the works/sources that you have used directly.

Furthermore, extensive amount of discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class activities will be performed with great respect toward differing ideas, perspectives, and traditions. The students are encouraged to seek guidance when they are in doubt (of any kind).

12 Students with disability

If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Resources at 703/993-2474

All academic accommodations must be arranged through that office.

13 Other useful university links

- The University catalogue http://catalog.gmu.edu/
- University policies http://universitypolicy.gmu.edu
- University library http://library.gmu.edu/
- Writing center http://writingcenter.gmu.edu/
- IT services http://itservices.gmu.edu

14 General philosophy

You should participate in all lectures and take your own notes. Listening to the lectures and participating in discussions will help you a lot.

For exams preparation, you should review your lecture notes, consider discussions during the lectures, and study your problem sheets extensively.
References


