Course Approval Form

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

Action Requested:

- [x] Create new course
- [ ] Inactivate existing course
- [ ] Reinstate inactive 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: College of Science
Department: Department of Physics and Astronomy
Submitted by: Erdal Yiğit
Ext: 3-2658
Email: eyigit@gmu.edu
Subject Code: PHYS
Number: 665
(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

Effective Term:

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

Year 2016

Title:
Current:
Banner (30 characters max w/ spaces): PlanetAtmospheres&Ionospheres
New: Planetary Atmospheres and Ionospheres

Fulfills Mason Core Req? (undergrad only)

- [ ] Currently fulfills requirement
- [ ] Submission in progress

Credits: (check one)

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

Repeat Status: (check one)

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

Maximum credits allowed: 3

Grade Mode: (check one)

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

Schedule Type: (check one) LEC can include LAB or RCT

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

Prerequisite(s):
PHYS 262 and MATH 214

Corequisite(s):

Instructional Mode:

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

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

Are there equivalent course(s)?

- [x] Yes
- [ ] No

If yes, please list PHYS 465

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

Approval Signatures

Department Approval	Date	College/School Approval	Date
	11/06/2015		

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 10/16/14

Course Proposal Submitted to the College of Science Curriculum Committee (COSCC)

The form above is processed by the Office of the University Registrar. This second page is for the COSCC's reference. Please complete the applicable portions of this page to clearly communicate what the form above is requesting.

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 separatly 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.

$$\partial n_i/\partial t + \nabla \cdot (n_i \mathbf{v_i}) = P_i - L_i$$

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 develep 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 performace 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

Homework	40%
One midterm exam	20%
One final exam	30%
Participation	10%
Term paper	0%

7.1.2 Graduate grading

Homework	30%
One midterm exam	10%
One final exam	20%
Participation	10%
Term paper	30%

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 reasearch 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 the histocal 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 Conlusions: 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 elses 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

Andrews, D. G., J. R. Holton, and C. B. Leovy (1987), *Middle Atmosphere Dynamics*, *International geophysics series*, vol. 40, Academic press.

Batchelor, G. K. (2000), *Introduction to fluid dynamics*, Cambridge Mathematical Library Series, Cambridge university press.

Chamberlain, J. W., and D. M. Hunten (1987), *Theory of planetary atmospheres: An introduction to their physics and chemistry*, *International geophysics series*, vol. 36, Academic press.

Hargreaves, J. K. (1992), *The solar-terrestrial environment*, Cambridge Atmospheric and Space Science Series, Cambridge university press.

Holton, J. R., and G. J. Hakim (2012), *An Introduction to dynamic meteorology*, 5th ed., Academic Press.

Moldwin, M. (2008), *An introduction to space weather*, Cambridge University Press.

Nappo, C. J. (2002), *An introduction to atmospheric gravity waves*, *International geophysics series*, vol. 85, Academic Press.

Prölss, G. W. (2004a), *Physics of the Earth's space environment*, Springer.

Prölss, G. W. (2004b), *Space Weather effects in the upper atmosphere: Low and Middle Latitudes*, *Lecture notes in physics*, vol. 656, Springer, doi:10.1007/b100037.

Rees, M. H. (1989), *Physics and chemistry of the upper atmosphere*, Cambridge atmospheric and space science series, Cambridge University Press.

Schunk, R. W., and A. F. Nagy (2009), *Ionospheres: Physics, plasma physics and chemistry*, Atmospheric and Space Science Series, Cambridge Univ. Press.

Vallis, G. (2006), *Atmospheric and oceanic fluid dynamics*, Cambridge University Press.

Yiğit, E. (2015), *Atmospheric and Space Sciences: Neutral Atmospheres*, SpringerBriefs in Earth Sciences, Springer, doi:10.1007/978-3-319-21581-5.