Course Approval Form

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

Action Requested: (definitions available at website above)
[x] Create NEW [ ] Inactivate
[ ] Modify (check all that apply below)

[ ] Title (must be 75% similar to original) [ ] Repeat Status [ ] Prereq/coreq [ ] Grade Mode
[ ] Credits [ ] Schedule Type [ ] Restrictions [ ] Other: _____

Course Level:
[x] Undergraduate [ ] Graduate

College/School: College of Science **Department:** AOES
Submitted by: Long Chiu **Ext:** 993-1984 **Email:** lchiu@gmu.edu

Subject Code: CLIM **Number:** 456
(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

Effective Term: [ ] Fall [x] Spring [ ] Summer *Year* 2017

Title:
Current: Introduction to Atmospheric Radiation
Banner (30 characters max w/ spaces):
New:

Fulfills Mason Core Req? (undergrad only)
[ ] Currently fulfills requirement
[ ] Submission in progress

Credits: (check one)
[x] Fixed → 3
[ ] Variable → to
[ ] Lec + Lab/Rct→ 0 or

Repeat Status: (check one)
[x] Not Repeatable (NR)
[ ] Repeatable within degree (RD) →
[ ] Repeatable within term (RT) →
Max credits allowed: (required for RT/RD status only)

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 if linked sections will be offered
[x] Lecture (LEC) [ ] Lab (LAB) [ ] Recitation (RCT) [ ] Internship (INT)
[ ] Independent Study (IND) [ ] Seminar (SEM) [ ] Studio (STU)

Prerequisite(s) (NOTE: hard-coding requires separate Prereq Checking form; see above website):
CLIM 111, MATH 114, and PHYS 260; or permission of the instructor

Corequisite(s):

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

Equivalencies (check only as applicable):
[x] YES, course is 100% equivalent to GGS 456
[ ] YES, course renumbered to or replaces

Catalog Copy (Consult University Catalog for models)

Description (No more than 60 words, use verb phrases and present tense)	**Notes** (List additional information for the course)
Provides fundamentals, physical understanding and quantitative analysis of radiative transfer in the atmosphere, discusses radiation processes- reflection, refraction, absorption, transmission, emission, and scattering and introduces tools for atmospheric radiative transfer. Provide students the basics for more advanced topics such as remote sensing or satellite meteorology.	

Indicate number of contact hours: Hours of Lecture or Seminar per week: _____ Hours of Lab or Studio: _____
When Offered: (check all that apply) [ ] Fall [ ] Summer [ ] 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

Undergraduate or Graduate Council Approval

UGC or GC Council Member Provost's Office UGC or GC Approval Date

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.

Course Number and Title: CLIM 456

Date of Departmental Approval: TBA

Reason for the New Course:

This is a cross-list for already-existing course GGS 456. The cross-list reflects the fact that an AOES faculty member will be teaching the course.

Relationship to Existing Programs: Currently GGS 456 is required for the Atmospheric Science requirement; AOES is considering revising program requirements so that CLIM 456 satisfies same requirement.

Relationship to Existing Courses: Cross-list with GGS 456. No other undergraduate class provides an in-depth study of how radiation interacts with the atmosphere.

Semester of Initial Offering: Spring 2017

Proposed Instructors: Long Chiu

CLIM 456 Introduction to Atmospheric Radiation

Instructor: Long Chiu

Catalog Description: Provides fundamentals, physical understanding and quantitative analysis of radiative transfer in the atmosphere, discusses radiation processes- reflection, refraction, absorption, transmission, emission, and scattering and introduces tools for atmospheric radiative transfer calculations. Provide students the basics for more advanced topics such as remote sensing or satellite meteorology.

Course Objectives: This course provides the fundamentals, physical understanding and quantitative analysis of atmospheric radiation. Students get an understanding of the radiative processes, to include reflection, refraction, absorption, transmission, emission, and scattering; radiative properties of surfaces, atmospheric gases, particles, and cloud for calculating the short wave and long wave fluxes, hence radiative heating/cooling rates, and the global radiation balance. Application to remote sensing techniques will also be briefly discussed.

Prerequisites: CLIM 111, MATH 114 and PHYS 260 or permission of instructor
Grading: Home work: 50%**,** Mid-term: 20%, Final: 30%
Course Text:
Petty, G., A First Course in Atmospheric Radiation, 2nd Edition, Sundog Publishing, Wisconsin, Madison, USA

Students attending class please email to instructor for group purchase. Individually, students can purchase the book themselves via the publisher http://www.sundogpublishing.com/ordering/online-orders/.

Course Outline

1. Introduction
    - 1.1 Relevance to Climate and Weather
    - 1.2 Relevance to Remote Sensing
2. Properties of Radiation
    - 2.1 The Nature of Electromagnetic Radiation and Energy
    - 2.2 Frequency
    - 2.3 Polarization
    - 2.4 Energy
    - 2.5 A Mathematical Description of EM Waves
    - 2.6 Quantum Properties of Radiation
    - 2.7 Flux and Intensity
    - 2.8 Insolation
3. The Electromagnetic Spectrum
    - 3.1 Frequency, Wavelength and Wavenumber
    - 3.2 Major Spectral Bands
    - 3.3 Solar and Terrestrial Radiation and Energy
4. Reflection and Refraction
    - 4.1 Index of Refraction
    - 4.2Reflectino and Refraction
    - 4.3 Rainbows and Halos
5. Radiative Properties and Natural Surfaces
    - 5.1 Natural Surface Idealized as Planar Boundaries
    - 5.2 Absorption and Reflectivity
    - 5.3 Angular Distribution of Reflected Spectra
    - 5.4 Solar Heating and Vis/IR Satellite Imaging
6. Thermal Emission

- 6.1 Blackbody Radiation
- 6.2 Emissivity
- 6.3 Thermal Emission Applications
- 6.4 Radiative Cooling and Global Radiation Balance

7. Atmospheric Transmission
   - 7.1 Extinction, Scattering and Absorption Coefficients
   - 7.2 Extinction over a Finite Path
   - 7.3 Plane Parallel Approximation
   - 7.4 Optical Thickness and Transmission of clouds
8. Atmospheric Emission
   - 8.1 Major Components of Radiative Transfer
   - 8.1 Radiative Transfer Equations
   - 8.2 Radiatiive Transfer in a Plane Parallel Atmosphere
   - 8.3 Emission Spectrum, Profile Retrieval and Water Vapor Imaging
9. Absorption by Atmosphere Gases
   - 9.1 Basis for Molecular Absorption/Emission
   - 9.2 Absorption/Emission Lines
   - 9.3 Line Shapes
   - 9.4 Continuum Absorption
   - 9.5 Atmospheric absorption in the IR
10. Broadband Fluxes and Heating Rates
    - 10.1 Line-by-line Calculations
    - 10.2 Band Transmission Models
    - 10.3 The K-Distribution Method
    - 10.4 Fluxes and Radiative Heating/cooling
11. Ratiative Transfer Equilibrium (RTE) with Scattering
    - 11.1 RTE with Scattering
    - 11.2 The Scattering Phase Function
    - 11.3 Single vs Multiple Scattering
    - 11.4 Atmospheric Visibility
12. Scattering and Absorption by Particles
    - 12.1 Atmospheric Particles
    - 12.2 Scattering by Small Particles
    - 12.3 Scattering by Spheres- Mie Theory
    - 12.4 Distribution of Particles
    - 12.5 Radar and Microwave Remote Sensing of Clouds
13. Radiative Transfer with Multiple Scattering
    - 13.1 Visualizing Multiple Scattering
    - 13.2 The Two-Stream Method
    - 13.3 Semi-Infinite Clouds
    - 13.4 Non-absorbing Clouds
    - 13.5 Clouds over Non-Black Surface
    - 13.6 Multiple Cloud Layers

Atmospheric RT Tools

14.1 MODTRAN http://climatemodels.uchicago.edu/modtran/
14.2 NCAR full spectral model http://forecast.uchicago.edu/Projects/full_spectrum.doc.html

If you have a documented learning disability or other condition that may affect academic performance you should: 1) contact the Office for Disability Services (SUB I, Rm. 4205; 993-2474; http://ods.gmu.edu) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs. In addition to providing your professor with the appropriate form, please take the initiative to discuss accommodation with me at the beginning of the semester and as needed during the term. Because of the range of learning differences, faculty members need to learn from you the most effective ways to assist you.

Academic Integrity
GMU is an Honor Code university; please see the Office for Academic Integrity 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. Discussions inside and outside of the classroom with me or your fellow students are encouraged, however, copying HW directly is prohibited. Cheating during exams is a violation of the code and will be reported to the University for appropriate action.

More information: http://www.gmu.edu/departments/unilife/pages/honorcode.html