GEORGE MASON UNIVERSITY

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
[ ] Graduate

College/School:	COS	**Department:**	AOES
Submitted by:	Barry Klinger	**Ext:** 3-9227	**Email:** bklinger@gmu.edu

Subject Code: CLIM **Number:** 512
(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

Effective Term: [X] Fall [ ] Spring [ ] Summer *Year* 2015

Title:
Current:
Banner (30 characters max w/ spaces):
New: Physical Oceanography

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

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

Repeat Status: (check one)
[x] Not Repeatable (NR)
[ ] Repeatable within degree (RD)
[ ] Repeatable within term (RT)
Maximum credits allowed:

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): MATH 113 or MATH 115; PHYS 160 or PHYS 243; or permission of instructor.

Corequisite(s):

Instructional Mode:
[ ] 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)? [ ] Yes [x] No
If yes, please list

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)
Course describes the global patterns of temperature, salinity, currents and waves in the world's oceans, and how these patterns influence marine biota, climate, and human activity. Course introduces key concepts which explain physical features of the ocean ranging from microscopic turbulence to global circulation.	

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 [ ] 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 ____

For Registrar Office's Use Only: Banner____________________________Catalog______________________________

revised 10/16/14

Course Number and Title: **CLIM 512**

Date of Departmental Approval: 24 November 2014

Reason for the New Course:

Overview. Course is for graduate students who would like to learn physical oceanography and do not know vector calculus and ordinary differential equations. Physical oceanography addresses ocean properties that are relevant for studies in climate, weather, marine biology, remote sensing, paleontology and geology.

Course Objectives. Students will gain a basic knowledge of the geographic distribution of physical properties of the ocean. They will be made aware of the key methods of collecting ocean data and modeling the ocean. Students will learn the basic concepts underlying the modern study of physical oceanography. They will gain experience answering simple mathematical questions concerning the magnitude and distribution of ocean currents and their relationship to temperature and salinity patterns, and learn to interpret observational ocean data.

Relationship to Existing Programs:

Course is designed to fulfill core Hydrosphere requirement for Earth Systems Science MS. Graduate students in other departments such as GGS and ESP are also interested in the subject matter.

Relationship to Existing Courses:

Course will be cross-listed with CLIM 412 Physical Oceanography which has been taught three times so far. This is the graduate version of the class. Compared to CLIM 412, CLIM 512 will have additional problems on Problem Sets and Exams and the Term Paper will be judged to a higher standard (both length and complexity). In the past, CLIM 412 has also been cross-listed with EVPP 505 Topics in Environmental Science.

Course covers similar topics as **CLIM 712 Physical and Dynamical Oceanography,** which is taken by Climate Dynamics PhD students but assumes familiarity with vector calculus and ordinary differential equations. The mathematical level of CLIM 512 is more suitable than CLIM 712 for many Earth Science MS students.

Semester of Initial Offering: Fall, 2016.

Proposed Instructors: Barry Klinger

Tentative Syllabus: See following pages.

CLIM 412/512
PHYSICAL OCEANOGRAPHY

-- SYLLABUS --

Instructor: Barry Klinger, bklinger@gmu.edu
Office Hours: Wed 10:00-12:00 and by appointment (please email)

Course Description:

Course describes the global patterns of temperature, salinity, currents and waves in the world's oceans, and how these patterns influence marine biota, climate, and human activity. Course introduces key concepts which explain physical features of the ocean ranging from microscopic turbulence to global circulation.

Prerequisites: MATH 113 or MATH 115, and PHYS 160 or PHYS 243, or permission of instructor.
Credits: 3

Homework: 8-12 problem sets.

Project: Term paper on physical oceanography subject.

Exams: Midterm and final exam with mixture of mathematical problems and short essay questions.

Grades:

Homework 25%, Term Paper 25%, Midterm 20%, Final Exam 30%

Difference in Assignments and Grading for CLIM 412 and CLIM 512:
Students enrolled in CLIM 512 will have additional problems on problem sets and in exams than students in CLIM 412. Term paper will be 5-10 single-spaced pages for CLIM 412 and 7-12 for CLIM 512 and will be judged to a higher standard for CLIM 512.

Required Texts:

Open University Course Team, 2001, *Ocean Circulation,* Butterworth-Heinemann, Oxford, UK.

Open University Course Team, 2000, *Waves, Tides, and Shallow-Water Processes,* Butterworth-Heinemann, Oxford, UK.

Background Reading:

Knauss, J. A., 1997: *Introduction to Physical Oceanography (2nd edition)***,** Prentice Hall, Upper Saddle River, NJ, USA. [Somewhat more mathematical explanation of physical laws of oceanography.]

Talley, L. D., G. L. Pickard, W. J. Emery, and J. H. Swift, 2011: *Descriptive Physical Oceanography, An Introduction (6th Edition),* 555 pp, Elsevier. [Comprehensive observational textbook.]

Marshall, J., and R. A. Plumb, 2007: *Atmosphere, Ocean and Climate Dynamics: An Introductory Text*, 344 pp., Academic Press. [Conceptual and mathematical basis of geophysical fluid dynamics for air and sea.]

Lecture Content:

- 1. Introduction
  - What is physical oceanography and why should I care?
  - Tools of the trade: measurement, math, models
  - Instruments and observations
  - Properties of seawater
- 2. Distribution of properties
  - Surface temperature and salinity
  - Heat and freshwater exchange with the atmosphere
  - Mixed layer, thermocline, and water masses
- 3. The effect of rotation on currents
  - Math review: vectors, etc.
  - The Coriolis force
  - Geostrophy

- 4. Wind-driven circulation – the local view
  - Ekman transport and pumping
  - Coastal upwelling and downwelling
  - Biological primary productivity and Ekman pumping
- 5. Wind-driven circulation – basin-wide circulations
  - Description of the gyres of the world
  - Potential vorticity and western boundary currents
  - Equatorial circulation
  - Antarctic Circumpolar Current

- 6. Deep Meridional Overturning Circulation
  - How deep water forms
  - Deep western boundary currents
  - Global deep circulation and meridional overturning cells
  - What drives the deep meridional overturning circulation?
- 7. Oceans and Climate
  - Basics of climate
  - Why the ocean is important for climate

- 8. Introduction to Waves
  - What is a wave?
  - Dispersion
- 9. Gravity Waves and Mixing
  - Surface Gravity Waves and Tsunamis
  - Internal Waves
  - Turbulence, mixing, and biological productivity

- 10. Waves in a Rotating Fluid; Eddies
  - Poincare waves and Kelvin waves
  - Rossby waves
  - Mesoscale eddies in the ocean

- 11. Tides
  - Tidal forcing
  - Large scale tides
  - Tides near coasts

- 12. Coastal Processes
    - Estuaries
    - River outflow plumes
    - Fronts

- 13. El Nino and low-frequency variability
    - El Nino-Southern Oscillation
    - Decadal variability
    - Global warming and the future of the seas