GEORGE MASON UNIVERSITY

Course Approval Form

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

registrar.gmu.edu/facultystaff/curriculum

Action Requested:

[x] Create new course [ ] Inactivate existing course
[ ] Modify existing course (check all that apply)
[ ] Title [ ] Credits [ ] Repeat Status [ ] Grade Type
[ ] Prereq/coreq [ ] Schedule Type [ ] Restrictions
[ ] Other: ______

Course Level:

[x] Undergraduate
[ ] Graduate

College/School:	College of Science	**Department:**	Atmospheric, Oceanic & Earth Sciences
Submitted by:	Barry Klinger	**Ext:** 3-9227	**Email:** bklinger@gmu.edu

Subject Code: CLIM **Number:** 470
(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

Effective Term: [X] Fall [ ] Spring [ ] Summer *Year* 2014

Title:
Current:
Banner (30 characters max including spaces): Numerical Weather Prediction
New: Numerical Weather Prediction

Credits: (check one) [x] Fixed 3 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 213, MATH 214, CLIM 311

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)? [ ] 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)
Concepts and techniques of numerical prediction of weather, including the numerical models used and the rationale for large suites of meteorological forecasts. Sources of errors in the forecast: errors in the initial conditions and in the numerical weather prediction models. Interpretation of model output.	

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 [x] 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______

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

1. <u>COURSE NUMBER AND TITLE</u>: CLIM 470: Numerical Weather Prediction

<u>Course Prerequisites</u>: MATH 213, MATH 214, CLIM 311

<u>Catalog Description</u>: Concepts and techniques of numerical prediction of weather, including the numerical models used and the rationale for large suites of meteorological forecasts. Sources of errors in the forecast: errors in the initial conditions and in the numerical weather prediction models. Interpretation of model output.

2. <u>COURSE JUSTIFICATION</u>:

<u>Course Objectives</u>: The students should gain a basic understanding of the weather modeling process and how errors in the numerical weather prediction models affect the solution. The students will become familiar with the history of the numerical weather prediction and its evolution before providing step-by-step descriptions of the various model components. Having the students appreciate the limitations of the numerical weather prediction is an important objective of the course. The well-know sources of errors will be described: errors in the initial conditions, in the numerical approximations, in the physical-processes parameterizations, and in the boundary conditions. The discussion on the ensemble methods will enable the students to understand the uncertainty in the numerical weather forecast. The students should become familiar with the techniques for post-processing and analyzing model output. The course will give the students a comprehensive of the techniques used in the numerical weather prediction and the skill that we can expect from these models.

<u>Course Necessity</u>: This course fills a gap in the atmospheric science curriculum in its focus on the theoretical and technical methods of numerical modeling of atmospheric processes.

<u>Course Relationship to Existing Programs</u>: This course will be a requirement in the (new) BS in Atmospheric Sciences degree.

<u>Course Relationship to Existing Courses</u>: Other departmental courses in the undergraduate curriculum teach students the scientific basis of atmospheric properties and behavior. In particular, CLIM 301 teaches students about how weather systems evolve over time. This course gives students the mathematical and technical tools needed to understand, use, and modify the computer models which actually forecast the weather. There are no other courses at GMU on this topic. CLIM 715 Numerical Methods for Climate Modeling includes some similar techniques for approximating atmospheric equations of motion, but treats them at a higher mathematical level appropriate for PhD students and emphasizes climate models which have some important differences from weather prediction models. CSI 721/722 Computational Fluid Dynamics I /II are also at a mathematically more sophisticated graduate level and describe numerical modelling of fluid systems in general instead of the specifics of modeling weather in the atmosphere.

3. <u>APPROVAL HISTORY</u>:

4. <u>SCHEDULING AND PROPOSED INSTRUCTORS</u>:

<u>Semester of Initial Offering</u>:
Spring 2015

<u>Proposed Instructors</u>:
Cristiana Stan

5. TENTATIVE SYLLABUS:

Format: The course will meet three times per week for lecture.
Prerequisites: MATH 213, MATH 214 or equivalent; CLIM 311.
Required Text:
Coiffier, Jean 2012: Fundamentals of Numerical Weather Prediction, Cambridge Press, ISBN 978-1-107-00103-9
Evaluation Criteria: The assessment of student performance will be based on homework assignments (30%), a mid-term examination (35%), and a final exam (35%).

Course Schedule:

Week 1: Introduction
- The early days of numerical weather prediction
- The beginning of modern numerical weather prediction
- Numerical weather prediction today
- Developments in computing

Week 2: What is a numerical weather prediction model?
- Weather prediction equations
- Physical parameterizations
- Data assimilation

Week 3: Grid point models
- The finite difference methods
- The common used grids and their properties

Week 4: Spectral models
- Spectral methods
- Spectral method on the sphere
- Spectral method on a double periodic domain

Week 5: Vertical discretization
- Hydrostatic/Non-hydrostatic models
- Sigma vertical coordinates
- Hybrid vertical coordinates

Week 6: Domain and boundary conditions
- Inflow boundaries
- Outflow boundaries
- Reflection of gravity waves at a wall

Week 7: Review of material; Mid-term examination

Week 8: Time integration schemes
- Non-iterative schemes
- Iterative schemes
- Time filtering

Week 9: Errors in the initial conditions and in the models
- **Errors in the initial conditions and their effects on the forecast**
- Aliasing errors
- The effects of time differencing on energy conservation
- Quality control of observations

Week 10: Operational Forecasting
- The forecasting process
- Ensemble forecasting
- Forecast verification

Week 11: Post-processing of model output
- Vertical interpolation
- Introduction to GrADS

Week 12 & 13: Examples of NWP models

The North American Mesoscale (NAM) forecast system

The Global Forecast System (GFS)

Week 14: Future prospects and Review of material