NUMERICAL WEATHER PREDICTION SYLLABUS

COURSE DESCRIPTION: Numerical Weather Prediction (NWP) focuses on the application of mathematical and computer techniques to analyze and predict the current and future states of the atmosphere. Initially, meteorological observations must be checked for accuracy and consistency and perhaps supplemented with artificial or bogus information. These data must then be numerically interpolated to uniform grids—a procedure known as numerical analysis. Next, a balancing or initialization of the gridded data is performed. Finally, the data can be used to initialize prediction models that are based on equations developed in Dynamic Meteorology I & II to predict the future state of the atmosphere. This course will cover some of the details associated with these steps in the automated analysis and prediction process and apply some basic techniques used in these areas. Some more simple topics will be covered in mathematical detail, whereas some more complex areas will only be described. Students will develop computer programs to perform many of the various steps in the NWP process and to test various theoretical concepts. Students will also learn about the configuration and capabilities of current operational numerical analysis and prediction models.

PURPOSE: This course is designed to acquaint students with the concepts, procedures, and problems associated with numerical weather prediction through discussion and actual computer application to real and simulated data. It will acquaint students with the technological and interdisciplinary basis of NWP.

PREREQUISITES: MT520 (Dynamic II), computer programming course (FORTRAN, C, C++, or PERL), consent of instructor.

COURSE OBJECTIVES: The basic objectives of this course are to develop the following:

a. Understanding the history and the basic sequence of procedures and theory used in numerical weather analysis and prediction.

b. Basic knowledge of quality control procedures used for checking observational data and the ability to create software to perform these operations.

c. Programs to perform automated gridded weather analysis.

d. Descriptive understanding of initialization and balancing procedures.

e. Numerical solutions to some simplified governing diagnostic and prognostic equations used in automated analyses and forecasts.

REQUIRED TEXT: None. This is a rapidly changing area and most text become obsolete by the time they are published.

USEFUL REFERENCES:


GRADING:

- 60% of the course grade is based on homework assignments/projects (variable weights depending on complexity)

- 20% of the course grade is based on a semester project presentation & written report.

- 10% of the course grade is based on the results of a mid-term exam on the following date
  -- Thursday, Apr 7

- 10% of the grade is based on a comprehensive final exam given on the last day of class (Friday, May 14)
I will use the following standard conversions to assess letter grades for graduate students:

<table>
<thead>
<tr>
<th>Percentage Range</th>
<th>Grade</th>
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</thead>
<tbody>
<tr>
<td>92.5-100%</td>
<td>A</td>
</tr>
<tr>
<td>89.5-92.4%</td>
<td>A-</td>
</tr>
<tr>
<td>86.5-89.4%</td>
<td>B+</td>
</tr>
<tr>
<td>82.5-86.4%</td>
<td>B</td>
</tr>
<tr>
<td>79.5-82.4%</td>
<td>B-</td>
</tr>
<tr>
<td>76.5-79.4%</td>
<td>C+</td>
</tr>
<tr>
<td>72.5-76.4%</td>
<td>C</td>
</tr>
<tr>
<td>69.5-72.4%</td>
<td>C-</td>
</tr>
<tr>
<td>below 69.5%</td>
<td>F</td>
</tr>
</tbody>
</table>

ATTENDANCE: Students are expected to attend class. Role will only be called at the beginning of the semester to verify rosters. However, unexcused absences that result in a missed homework/mid-term/exam will automatically result in a zero grade for that measure. An oral make-up exam will normally be given to those in the advent of an excused absence. The only valid reasons for an excused absence are as follows:

- Documented student’s participation in official University-sponsored events
- Student’s documented illness
- Student’s documented injury
- Documented death in the student’s immediate family
- Documented illness or injury in a student’s immediate family
- Documented student’s military duty
- Documented student’s required jury duty

Please contact me in advance by e-mail or phone, preferably prior to an absence. Late notification may deem the excuse as invalid.

OFFICE HOURS: My formally scheduled office (B317) hours are as follows:

- MWF 1:30 p.m. - 2:30 p.m.
- R 11:00 a.m. – 12:00 noon

However, don't feel bound by these hours. Feel free to stop by my office (B317) at any time. If you want to schedule a fixed time or discuss something with me over the phone, please call me at ext. 52574. My e-mail address is koermer@plymouth.edu. My home phone number is 536-5056.

CELL PHONES: Cell phones should be turned off or set to vibrate only (if you are expecting an emergency call) before the start of class. You will not be allowed to use your cell phone when taking a quiz, test, or exam.

EAR BUDS: Ear buds are not to be worn during class time.

BATHROOM ISSUES: Students should take care of business before coming to class. You shouldn’t be getting up to leave for a bathroom break in the middle of a class.

Plymouth State University is committed to providing students with documented disabilities equal access to all university programs and facilities. If you think you have a disability requiring accommodations, you should immediately contact the PASS Office in Lamson Library (535-2270) to determine whether you are eligible for such accommodations. Academic accommodations will only be considered for students who have registered with the PASS Office. If you have a Letter of Accommodation for this course from the PASS Office, please provide the instructor with that information privately so that you and the instructor can review those accommodations.
MT5620 NWP COURSE OUTLINE

1. Introduction
   a. Historical Background of NWP
   b. Basic Concepts and Procedures (Flow Process)

2. Decode and Validation of Observational Data
   a. Decipher Encoded Data
   b. Data Quality Control
   c. "BOGUS" Data

3. Automated Objective Analysis
   a. Evolution of Objective Analysis
   b. Some Basic Approaches to Objective Analysis

4. Automated Grid Point Analysis Methods
   a. Successive Correction (Cressman) Method
   b. Optimum Interpolation (OI) Methods
      -- Univariate Analysis
      -- Multivariate Analysis

5. Surface Fitting Analysis Methods
   a. Local Least-Squares Fit
   b. Hough Function/Spectral Analysis

6. Additional Concepts/Characteristics of Objective Analysis
   a. Resolution
   b. Sampling
   c. "First Guess" Fields
   d. Imperfect Data
   e. “Bogusing” Techniques

7. Balance and Initialization
   a. Dynamic Imbalance
   b. Geostrophic Adjustment
   c. Non-Linear Normal Mode Initialization
   d. Forecast Model Input
   e. Convective Adjustment
8. Generalized Differential Equations
   a. Common Types in NWP
      -- Diagnostic Type
      -- Prognostic Type
   b. Methods of Solution
      -- Finite Difference
      -- Spectral Techniques
      -- Finite Element

   a. Truncation Error
   b. Consistency
   c. Convergence
   d. Stability

10. Spatial Finite Differencing
    a. Left/Right/Center
    b. Second Derivatives and Elliptic Equations

11. Temporal Finite Differencing
    a. Non-Iterative, Two-Level Schemes
    b. Iterative, Two-Level Schemes
    c. Non-Iterative, Three-Level Schemes
    d. Others

12. Vertical Coordinate Systems
    a. Cartesian
    b. Pressure
    c. Sigma
    d. Other
    e. Numerical Integration

13. Horizontal Coordinate Systems and Map Projections
    a. Spherical
    b. Polar Stereographic
    c. Mercator

14. Operational NWP in the National Weather Service

15. Graduate Student Presentation(s) on Various Mesoscale Topics Not Covered in Class