Course Title

Introduction to Mathematical Modeling

Course Number
MATH-UA 9251

Spring 2015

Syllabus last updated on: 14-Dec-2014

Instructor Contact Information
Nikki Vercauteren
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Course Details
When: Spring 2015, Mondays 5:00pm – 7:45pm
Where: Academic Center, room “tbc”

Prerequisites
MATH-UA 121 Calculus I, MATH-UA 122 Calculus II and MATH-UA 123 Calculus III or equivalents with a grade of C or better.

Units earned
4 points

Course Description
In this course, students will learn how to formulate and analyze mathematical models. The mathematical tools to be handled include dimensional analysis, optimization, numerical simulation, elementary probability and stochastic processes, as well as elementary differential equations. The fields of application include biology, economics, and other areas of science.

The necessary mathematical and scientific background will be developed as needed. Students will learn how to simulate models using MATLAB.

Course Objective
Students will learn how to formulate, analyze and simulate mathematical models.

Assessment Components
The results of homework assigned weekly or biweekly (30%), the midterm exam (25%; 1.5 hours) and a final research project (45%, 5-10 pages report and a short presentation) will be combined.

Failure to submit or fulfill any required component may result in failure of the class, regardless of grades achieved in other assignments.
Assessment Expectations

**Grade A:** The student makes excellent use of empirical and theoretical material and offers well-structured arguments in his/her work. The student writes comprehensive essays/exam questions and his/her work shows strong evidence of critical thought and extensive reading.

**Grade B:** The candidate shows a good understanding of the problem and has demonstrated the ability to formulate and execute a coherent research strategy.

**Grade C:** The work is acceptable and shows a basic grasp of the research problem. However, the work fails to organize findings coherently and is in need of improvement.

**Grade D:** The work passes because some relevant points are made. However, there may be a problem of poor definition, lack of critical awareness, poor research.

**Grade F:** The work shows that the research problem is not understood; there is little or no critical awareness and the research is clearly negligible.

**Grade Conversion**

NYU Berlin uses the following scale of numerical equivalents to letter grades:

- **B+** = 87-89
- **C+** = 77-79
- **D+** = 67-69
- **F** = below 65

- **A** = 94-100
- **B** = 84-86
- **C** = 74-76
- **D** = 65-66

- **A-** = 90-93
- **B-** = 80-83
- **C-** = 70-73

Alternatively, your professor may give your grades in the scale of 0 to 4:

- A= 4.0
- A- = 3.7
- B+ = 3.3
- B = 3.0
- B- = 2.7
- C+ = 2.3
- C = 2.0
- C- = 1.7
- D+ = 1.3
- D = 1.0
- F = 0.0.

**Attendance Policy**

Participation in all classes is essential for your academic success, especially in NYU Berlin’s content courses that, unlike most courses at NYU NY, meet only once per week in a double-session for three hours. Your attendance in both content and language courses is required and will be checked at each class meeting. As soon as it becomes clear that you cannot attend a class, you must inform your professor by e-mail immediately. Absences are only excused if they are due to illness, religious observance or emergencies. If you want the reasons for your absence to be treated confidentially and not shared with your professor, please approach NYUB’s Director or Wellness Counselor. Your professor or NYUB’s administration may ask you to present a doctor's note or an exceptional permission from the Director or Wellness Counselor.

Unexcused absences affect students’ grades: In content courses each unexcused absence (equaling one week's worth of classes) leads to a deduction of 2% of the overall grade and may negatively affect your class participation grade. Three unexcused absences in one course may lead to a Fail in that course. In German Language classes three (consecutive or non-consecutive) unexcused absences (equaling one week's worth of classes) lead to a 2%
deduction of the overall grade. Five unexcused absences in your German language course may lead to a Fail in that course. Furthermore, faculty is also entitled to deduct points for frequent late arrival to class or late arrival back from in-class breaks. Being more than 15 minutes late for class counts as an unexcused absence. Please note that for classes involving a field trip or other external visit, transportation difficulties are never grounds for an excused absence. It is the student's responsibility to arrive at the announced meeting point in a punctual and timely fashion.

Exams, tests, deadlines, and oral presentations that are missed due to illness require a doctor's note as documentation. It is the student's responsibility to produce this doctor's note; until this doctor's note is produced the missed assessment is graded with an F. In content classes, an F in one assignment may lead to failure of the entire class.

**Attendance Rules on Religious Holidays**
Members of any religious group may, without penalty, excuse themselves from classes when required in compliance with their religious obligations. Students who anticipate being absent because of any religious observance should notify the Director or Assistant Director for Academics in advance of the anticipated absence. If examinations or assignment deadlines are scheduled on the day the student will be absent, the Director or Assistant Director will re-schedule a make-up examination or extend the deadline for assignments.

**Late Submission of Work**
(1) Written work due in class must be submitted during the class time to the professor.

(2) Late work should be submitted in person to the instructor or to the Assistant Director for Academics, who will write on the essay or other work the date and time of submission, in the presence of the student. Another member of the administrative staff may also personally accept the work, and will write the date and time of submission on the work, as above.

(3) Unless an extension has been approved (with a doctor's note or by approval of the Director or Assistant Director), work submitted late receives a penalty of 2 points on the 100 point scale for each day it is late.

(4) Without an approved extension, written work submitted more than 5 weekdays following the session date fails and is given a zero.

(5) End of semester essays must be submitted on time.

(6) Students who are late for a written exam have no automatic right to take extra time or to write the exam on another day.

(7) Please remember that university computers do not keep your essays - you must save them elsewhere. Having lost parts of your essay on the university computer is no excuse for a late submission.

**Plagiarism Policy**
The presentation of another person’s words, ideas, judgment, images or data as though they were your own, whether intentionally or unintentionally, constitutes an act of plagiarism. Proper
referencing of your sources avoids plagiarism (see as one possible help the NYU library guide to referencing styles: http://nyu.libguides.com/citations).

NYUB takes plagiarism very seriously; penalties follow and may exceed those set out by your home school. All your written work must be submitted as a hard copy AND in electronic form to the instructor. Your instructor may ask you to sign a declaration of authorship form. All assignments in this course will be checked for plagiarism using TurnItIn.

It is also an offense to submit work for assignments from two different courses that is substantially the same (be it oral presentations or written work). If there is an overlap of the subject of your assignment with one that you produced for another course (either in the current or any previous semester), you MUST inform your professor.

Required Text(s)
No books required

Supplemental Text(s) (not required to purchase)

Internet Research Guidelines
To be discussed in class

Additional Required Equipment
None

Session 1 – 2 Feb 2015
Arguments from scales: Dimensional analysis

Session 2 – [9 Feb 2015]
Arguments from data: Least squares, parameter estimation

Session 3 – [16 Feb 2015]
Linear models: Generalized least squares estimators and time series analysis

Session 4 – [23 Feb 2015]
Mathematical models in biology: Population models, predator-prey systems

Session 5 – [2 Mar 2015]
Stability analysis: Equilibria, oscillations, growth and decay

Session 6 – [9 Mar 2015]
Optimal control and application in fishery management

Session 7 – [16 Mar 2015]
Markov chains and the PageRank algorithm
Midterm exam (1.5 hours)

Session 8 – [23 Mar 2015]
Markov processes: Modeling of chemical reactions

Session 9 – [30 Mar 2015]
Mathematical modeling of planet earth: Introduction to modeling of atmospheric flows and to glacier dynamics.

6 April 2015: Spring Break – No Class

Session 10 – [13 Apr 2015]
Difference equations: Microscopic modeling of traffic flows

Session 11 – [20 Apr 2015]
Conservation laws: Macroscopic modeling of traffic flows

Session 12 – [27 Apr 2015]
Sociological models: Functional equations

Session 13 – [4 May 2015]
Optimization under constraints: Variational calculus in nutshell

MaxEnt: Maximum entropy principles in ecology and physics

Session 15 – [18 May 2015]
Project presentations (20 minutes + 15 minutes discussion)

Classroom Etiquette
To be discussed in class

Required Co-curricular Activities
None

Suggested Co-curricular Activities
To be defined.

Your Instructor
Nikki Vercauteren is a postdoctoral research fellow of the Alexander von Humboldt foundation at FU Berlin. Her field of research is atmospheric dynamics, with a special focus on the stochastic modeling of atmospheric turbulence.