# Syllabus for MATH 4073, Numerical Analysis I, Sec. 001
# Fall 2016

**Lectures:** MWF 10:30–11:20 a.m. in 100 PHSC
**Class web page:** `http://www2.math.ou.edu/~npetrov/math4073_f16.html`

**Instructor:** Prof. Nikola Petrov, `npetrov@ou.edu`, 802 PHSC, office phone 325-4316
**Office Hours:** Tue 12:00–1:00 p.m., Fri 1:30 p.m.–2:30 p.m., or by appointment, in 802 PHSC

**Course catalog description:** Solution of linear and nonlinear equations, approximation of functions, numerical integration and differentiation, introduction to analysis of convergence and errors, pitfalls in automatic computation, one-step methods in the solutions of ordinary differential equations. (F)

**Prerequisite:** MATH 3113 (Intro to ODEs) or 3413 (Physical Math I)

**Text:** R. L. Burden, J. D. Faires. *Numerical Analysis*, 9th edition, 2010, Brooks/Cole, ISBN-10: 0538733519, ISBN-13: 978-0538733519

**Course Objectives:** This course is intended to be a mathematical introduction to the theory and practical use of certain basic numerical methods that often arise in applications. While the emphasis of the course will be placed solidly on applications, we will discuss some of the mathematical theory behind the methods we study. Some theoretical understanding is critical to the proper practice of numerical analysis because no numerical method works 100 % of the time. Thus when a method fails, the theory behind the method can often illuminate what went wrong and perhaps give insights into alternative approaches that may work better for the given problem.

**Course Content:**

- Review of pertinent concepts from calculus.
- Computer arithmetic and round-off errors.
- Algorithms and convergence.
- Solutions of equations in one variable (bisection method, Newton's method, error analysis).
- Interpolation and polynomial approximation (Lagrange polynomials, cubic splines).
- Numerical differentiation and integration (Richardson's extrapolation, Newton-Cotes formulae for integration, Romberg integration, Gaussian quadrature).
- Initial-value problems for ordinary differential equations (Euler's method, higher-order Taylor methods, Runge-Kutta methods).

**Grading:** Your grade will be based on the following:

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| Homework (lowest grade dropped) | 25 % |
| Quizzes (lowest grade dropped) | 5 % |
| Two midterm exams | 20 % each |
| Final exam | 30 % |

Course grades will be assigned by calculating the total for each student in the class, listing the totals in rank order, and assigning grades according to a reasonable total needed for each letter. After each in-class examination, I will announce tentative grades, so by the middle of the course you will have a good idea of where you stand, and what is required for a given grade.

**Exam dates:**

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| Midterm Exam 1 | Monday, October 3 (tentative), in class |
| Midterm Exam 2 | Monday, November 14 (tentative), in class |
| Cumulative Final Exam | Friday, December 16, 8:00–10:00 a.m. |

No books or notes may be used during exams. Do not make travel plans that prevent you from taking any of the tests or the final exam at the scheduled time. If you have a legitimate reason for missing an exam that can be documented independently of your testimony (e.g., via a note or phone call from a doctor or a parent), you must contact me prior to the exam, in order to make an alternative arrangement. I am very fastidious about such matters, so don't expect such arrangements unless you have a compelling excuse that meets the above conditions (especially the "prior notice" part).

**Attendance:** You are expected to attend all lectures, and you are responsible for all information given out during them. You are expected to arrive on time for the lectures, properly prepared and in good physical condition – in particular, adequately rested and up to date on the course material – so that you can maintain full concentration for the entire lecture.

All electronic equipment should be turned off before the start of every lecture, and should remain off until the class is dismissed. Since learning calculus requires your full attention, activities such as *conversing with other students, eating, sleeping, reading a newspaper, listening to headsets, using computers, cell phones, or other electronic devices, are not allowed!*

**Homework and quizzes:** The homework assignments will be given regularly throughout the semester on the class web site. Each homework will consist of several problems, of which *some* chosen pseudo-randomly will be graded. Your homework solutions must be submitted to me at the beginning of class on the due date or in my office (802 PHSC) no later than 3:30 p.m. on the due date (if I am not in my office, you may slide it under the door). Giving just an answer to a problem is not worthy any credit – you have to write a complete solution which gives your step-by-step reasoning and is written in grammatically correct English. Although good exposition takes time and effort, writing your thoughts carefully will greatly increase your understanding and retention of the material. The grader has the right to refuse to grade a homework paper that is illegible or excessively sloppy. *Your lowest homework grade will be dropped.*

*The problems in your homework should be in the order listed in the assignment, and the sheets should be stapled. No late homework will be accepted!*

You are encouraged to discuss the homework problems with other students, but you should write up the solutions in your own words. Copying solutions from a solutions manual, from someone else's work, or from the Internet is a complete waste of time, as you will not learn the material adequately, and you will pay a heavy price on the quizzes and the exams which constitute 75 % of your course grade.

Short in-class quizzes will be given at times that will be announced in advance. *There will be no make-up quizzes!* If you miss several quizzes due to a legitimate reason (see above), talk to me as soon as possible. *Your lowest quiz grade will be dropped.*

**Technology:** This is a *mathematics* course. Consequently, we will emphasize the mathematical underpinnings of numerical analysis and deliberately de-emphasize acquiring expertise with any particular computer programming language or software package. However, we will frequently engage in computations to illustrate the mathematical results that we derive. For all computations required on in-class exams, as well as for most computations required on homework problems, a most basic calculator (do *not* buy an expensive graphing calculator). Even if the complexity of the numerical methods requires the use of a coputer, the amount of programming you will need to do will be very small, and previous programming experience is not assumed. In this class we will use MATLAB and Mathematica to illustrate how some algorithms are implemented and analyze their performance. MATLAB and Mathematica are available on the computers in the University computer labs. You can install on your computer for free Mathematica a student version of MATLAB – go to `https://itstore.ou.edu` and log in with your 4×4, then click on Software downloads, download the software you need, and follow the installation instructions.

**Some important dates:**

(1) Last day to withdraw with an automatic $W$: Friday, October 28, 2016 for undergraduate students and Friday, September 20, 2016 for graduate students.

(2) Last day to withdraw without petition to the Dean: Friday, October 28, 2016 (for graduate students a $W/F$ grade is assigned for withdrawals processed during the period October 3–October 28).

(3) Labor day (no classes): Monday, September 5, 2016.

(4) Thanksgiving vacation (no classes): Wednesday, November 23–Friday, November 25, 2016.

(5) Last day of classes: Friday, December 9, 2016.

**Policy on *W/I* grades:** Through the end of the sixth week of the semester, students can withdraw from the course with an automatic $W$. Between the seventh and tenth weeks of the semester, undergraduate students can continue to withdraw with an automatic $W$, but graduate students must obtain the instructor's signature on the University's "drop form" to withdraw from the course, and along with the signature the instructor must indicate whether the student is passing or failing at the time of the withdrawal. After the tenth week of the semester, all students can only withdraw via petition to the Dean of their college. The petition process also requires the instructor's signature with a passing-failing indication at the time the petition is filed. Note that a "failing" indication on the petition means that even if the petition is approved the grade in the course will be weighted in the GPA as an $F$.

The grade of $I$ is not intended to serve as a benign substitute for the grade of $F$, and is only given if a student has completed the majority of the work in the course at a passing level (for example everything except the final exam), the course work cannot be completed because of compelling and verifiable problem beyond the student's control, and the student expresses a clear intention of making up the missed work as soon as possible. Moreover, current OU policies require that instructors and the affected students execute a written "Incomplete Contract" before a grade of $I$ can be given. The contract makes clear: (1) what work is to be made up; (2) when the make-up work must be completed (which cannot be more than one calendar year from the assignment of the $I$); and (3) *what alternative grade will be assigned if the make-up work is not completed*. If the make-up work specified in the contract is not made up within one calendar year, then the alternative grade specified in the contract will be entered on the student's transcript. Thus the $I$ grade does not became permanent on the transcript if it is not made up within one year.

**Academic Misconduct:** All cases of suspected academic misconduct will be referred to the Dean of the College of Arts and Sciences for prosecution under the OU Academic Misconduct Code. The penalties can be quite severe. *Don't do it!* For more details on the OU policies concerning academic misconduct see

`http://integrity.ou.edu/files/Academic_Misconduct_Code.pdf`

This link also has information about students' rights to appeal charges of academic misconduct. For information about admonitions (either accepting or contesting them) see

`http://integrity.ou.edu/files/Admonition.pdf`

Students are also bound by the provisions of the *OU Student Code*, which can be found at

`http://judicial.ou.edu/content/view/27/32/`

**Students with disabilities:** The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with the instructor as early in the semester as possible. Students with disabilities must be registered with the Office of Disability Services prior to receiving accommodations in this course. The Office of Disability Services is located in Goddard Health Center, Suite 166: phone 405–325–3852 or TDD (only) 405–325–4173.

Caminante, son tus huellas
el camino y nada más;
caminante, no hay camino,
se hace camino al andar.
Al andar se hace camino,
y al volver la vista atrás
se ve la senda que nunca
se ha de volver a pisar.
Caminante, no hay camino,
sino estellas sobre la mar.

Traveler, your footsteps
are the road and nothing more;
traveler, there is no road,
the road is made by walking.
By walking the road is made
and when we turn to look back
we see the path that
will never be traveled again.
Traveler, there is no road,
only tracks of foam on the sea.

From *Proverbios y Cantares*, Antonio Machado (1875–1939)