MIT Concourse – 18.03 Syllabus – Spring 2017

Course Meeting Times:
Lectures (Robert Winters): 2 sessions/week (Tues, Thurs 1:30pm-3:00pm, 90 minutes/session)
Recitations (Robert Winters): Choose either Tues, Thurs 11:00am to noon or 2:00pm-3:00pm, 1 hour/session)
An optional, informal weekly session covering some more theoretical aspects of the course may also be scheduled.

Course website: http://math.rwinters.com/1803

Prerequisites/Corequisites:
18.01 (Single Variable Calculus) is a prerequisite; *18.02 (Multivariable Calculus)* is a corequisite, meaning students may take 18.02 and 18.03 simultaneously.

Texts: There is no specific required text for the course, but good references are:

(1) *Differential Equations & Linear Algebra* by Farlow, Hall, McDill, West (Pearson, ISBN #9780131860612); or

(2) *Elementary Differential Equations with Boundary Value Problems, 6th Edition* by Edwards & Penney text (Upper Saddle River, NJ: Prentice Hall, 2008. ISBN: 9780136006138. [Note: The 5th Edition (ISBN: 9780131457744, published in 2003) will serve as well.]

We will also make great use of "18.03: Notes and Exercises" by Arthur Mattuck, and "18.03 Supplementary Notes" by Haynes Miller (both available online at no cost) as well as lecture notes prepared specifically for our course. If applicable, we may also reference additional materials from the mainstream course.

Description (*this will be revised somewhat to reflect an added emphasis on Linear Algebra with somewhat less time dedicated to Laplace Transform methods*):
This course is a study of Ordinary Differential Equations (ODE's), including modeling physical systems. Topics include:

- Solution of First-order ODE's by Analytical, Graphical and Numerical Methods;
- Linear ODE's, Especially Second Order with Constant Coefficients;
- Undetermined Coefficients and Variation of Parameters;
- Sinusoidal and Exponential Signals: Oscillations, Damping, Resonance;
- Complex Numbers and Exponentials;
- Fourier Series, Periodic Solutions;
- Delta Functions, Convolution, and Laplace Transform Methods;
- Matrix and First-order Linear Systems: Eigenvalues and Eigenvectors; and
- Non-linear Autonomous Systems: Critical Point Analysis and Phase Plane Diagrams.

The Concourse version of the 18.03 course will closely parallel the mainstream 18.03 course.

Lectures
The lecture period is used to help students gain expertise in understanding, constructing, solving, and interpreting differential equations. Students should come to lecture prepared to participate actively.

Recitations
These meet twice a week to discuss and gain experience with the course material. Even more than the lectures, the recitations involve active participation. Students are encouraged to ask questions early and often.

Office Hours
Regular office hours at times to be determined. You are encouraged to drop by for any matters that cannot adequately be addressed in class.

Tutoring
Tutors/graders are available within Concourse. Another resource of great value to students is the Mathematics Department tutoring room. This is staffed by experienced undergraduates. This is a good place to go to work on homework (as is the Concourse Lounge).

Videos
You may find the 18.03 lecture videos of Arthur Mattuck helpful. They are available on the Open Courseware site and were recorded in Spring 2003.

The Ten Essential Skills
Students should strive for personal mastery over the following skills. These are the skills that are used in other courses at MIT. This list of skills is widely disseminated among the faculty teaching courses listing 18.03 as a prerequisite. At the moment, 140 courses at MIT list 18.03 as a prerequisite or a corequisite.

1. Model a simple system to obtain a first order ODE. Visualize solutions using direction fields and isoclines, and approximate them using Euler's method.
2. Solve a first order linear ODE by the method of integrating factors or variation of parameter.
3. Calculate with complex numbers and exponentials.
4. Solve a constant coefficient second order linear initial value problem with driving term exponential times polynomial. If the input signal is sinusoidal, compute amplitude gain and phase shift.
5. Compute Fourier coefficients, and find periodic solutions of linear ODEs by means of Fourier series.
6. Utilize Delta functions to model abrupt phenomena, compute the unit impulse response, and express the system response to a general signal by means of the convolution integral.
7. Find the weight function or unit impulse response and solve constant coefficient linear initial value problems using the Laplace transform together with tables of standard values. Relate the pole diagram of the transfer function to damping characteristics and the frequency response curve.
8. Calculate eigenvalues, eigenvectors, and matrix exponentials, and use them to solve first order linear systems. Relate first order systems with higher-order ODEs.
9. Recreate the phase portrait of a two-dimensional linear autonomous system from trace and determinant.
10. Determine the qualitative behavior of an autonomous nonlinear two-dimensional system by means of an analysis of behavior near critical points.

The Ten Essential Skills is also available as a PDF (see course website).

Homework:
Homework assignments typically will consist of a combination of routine skill-based problems drawn from a textbook or notes, and other problems that may be more searching and interpretive. Both kinds of problems will be tied to topics presented in the lectures. Students should form the habit of doing the relevant problems between successive lectures and not try to do the whole set the night before they are due.

Exams:
There will be 3 one-hour exams held during either a lecture class or a recitation. There will also be a three-hour comprehensive final examination.

Grading:
The final grade will be based on the following scheme (subject to minor modification):
25% homework, 40% hour exams, 35% Final Exam

ODE Manipulatives ("Mathlets"):
This course employs a series of specially written Java™ applets, or Mathlets, developed by the Mathematics Department. They may be used in lecture occasionally, and each problem set typically contains a problem based around one or another of them.