2.003 Dynamics and Control I – Fall 2016
Syllabus

Staff

Lecturer Prof. Themistoklis Sapsis sapsis@mit.edu
Recitation Instructors
Prof. Kim Vandiver kимв@mit.edu
Prof. Nicholas Makris makris@mit.edu
Teaching Assistants
Mr. ByungGu Cho bgcho@mit.edu
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Scheduling

Lectures Tuesdays 9:35 am - 10:55 am 10-250
Thursdays 9:35 am - 10:55 am 10-250
Recitations Thursdays 12:00 pm - 1:00 pm 5-233
Thursdays 1:00 pm - 2:00 pm 5-233
Thursdays 3:00 pm - 4:00 pm 5-233
Thursdays 4:00 pm - 5:00 pm 5-233
Fridays 2:00 pm - 3:00 pm 1-246
Fridays 3:00 pm - 4:00 pm 1-246
Office Hours Sundays 2:00 pm - 4:00 pm 3-370 (TAs)
Mondays 6:00 pm - 9:00 pm 1-134 (TAs)
Wednesdays 3:00 pm - 4:00 pm 4-402 (Prof. Vandiver)
Thursdays 11:00 am - 12:00 pm 5-318 (Prof. Sapsis)
Thursdays 2:00 pm - 3:00 pm 5-233 (Prof. Makris)

Exam Dates
Exam I Tuesday, September 27, 2016 Walker Memorial: 50-340
Exam II Thursday, October 20, 2016 Walker Memorial: 50-340
Exam III Tuesday, November 15, 2016 Walker Memorial: 50-340
Exam IV Finals Week: TBD TBD

Course Calendar
A public Google calendar entitled “2.003”, which you can overlay on your other Google calendars, is posted on the MITx website at
https://lms.mitx.mit.edu/courses/MITx/2.003r_4/2016_Fall/calendar/
We will keep this calendar current with office hours and all other class-related activities.

**Learning Objectives**

Upon completion of the first half of the course (2.03), the student is expected to be able to

1. Analyze kinematics of systems with multiple rigid bodies with constraints
   - Apply intermediate coordinate systems to calculate position, velocity and acceleration of points on rigid bodies undergoing translation and rotation
   - Apply constraints to systems of rigid bodies. Determine the number of degrees of freedom and suitable generalized coordinates.
   - Evaluate vector arithmetic including dot products and cross products as it pertains to calculation of kinematic quantities.

2. Apply momentum principles to derive equations of motion for systems of rigid bodies
   - Draw free body diagrams
   - Apply the principle of linear momentum to systems of rigid bodies
   - Apply the principle of angular momentum to systems of rigid bodies
   - Apply work-energy principle to derive a single equation of motion
   - Apply impulse-momentum principle to systems involving impact

3. Integrate a single nonlinear equation of motion using MATLAB

Upon completion of the second half of the course (2.031), the student is expected to be able to do everything listed above, and additionally be able to

1. Apply the Euler-Lagrange equations to derive systems of equations of motion
   - Calculate kinetic energy of systems of rigid bodies
   - Calculate potential energy of systems of rigid bodies
   - Calculate generalized forces corresponding to non-conservative forces
   - Evaluate the requisite derivatives

2. Analyze the behavior of the motion for a single degree of freedom
   - Find equilibrium configurations
   - Linearize the equation of motion about the equilibrium configurations
   - Determine whether the resulting equilibrium configurations are stable or unstable

3. Integrate systems of nonlinear equations of motion using MATLAB

4. Analyze the resulting motion (vibrations) of stable systems
   - Determine whether the system is underdamped, critically damped or overdamped
   - Determine the free (transient) response of the system, including natural frequencies and mode shapes for multiple DoF systems
   - Determine the behavior of systems under forced vibration. Determine steady-state amplitude and phase lag.
Pre-Requisites

Pre-requisite: Physics II  
Co-requisite: 18.03 or 2.087

If you do not meet these, please visit one of the professors during office hours to discuss this.

Recitations

Attendance at recitations is required and will comprise 6 percent of your grade. Reassignment of recitation sections is only permitted during the first two weeks of the term with consent of the recitation instructors if you have a serious scheduling conflict. In the event of a serious scheduling conflict, please send the recitation instructors an email explaining the conflict and copy the teaching assistants for any requests to transfer sections.

Textbook

There is no required textbook. Excerpts from the following texts will be posted on the course website, and the books will be on reserve in Barker Library.

- Williams. *Fundamentals of Applied Dynamics*
- Rao. *Mechanical Vibrations*

Course Website

This course will use MITx for delivery of course content and assessment of student learning via electronically graded homework and upload of digital copies of written homework. The website is

https://lms.mitx.mit.edu/courses/MITx/2.003r_4/2016_Fall/info

Discussion Forum

There is a discussion forum provided on the MITx site.

https://lms.mitx.mit.edu/courses/MITx/2.003r_4/2016_Fall/discussion/forum

Please use it for any questions that may be of interest to other students. You can post anonymously or with your name attached. You are encouraged to respond to other students’ posts. The teaching assistants will also monitor the forum and provide answers to questions you post there.

Grading

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exams</td>
<td>76%</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>18%</td>
</tr>
<tr>
<td>Recitation Attendance and Participation</td>
<td>6%</td>
</tr>
</tbody>
</table>
Exams

There will be four exams. The first three will take place during class time, and the dates have been listed above. The fourth exam will take place during the final exam period. Exams are closed book/closed note/no phone/no calculator with a single page (front and back) of formulas allowed.

The teaching staff believe the best strategy for preparing for the exams is honestly doing the homework and working practice problems from old exams, which will be posted on the MITx site.

Homework

Weekly homework will be distributed on MITx. The purpose of the homework is to provide you with practice to build proficiency in solving problems so you can meet learning objectives assessed on exams and earn a good grade in the class. The homework will contain three components.

The first component is conceptual questions. These are short questions that do not require lengthy calculations. Each conceptual question pertains in some way to one of the longer homework problems. Conceptual questions are due at the start of your recitation section and completion of them counts towards the “Recitation Attendance and Participation” component of your grade.

The second component of homework is on-line questions, which are automatically graded by MITx, providing you with instantaneous feedback. The auto-check function is a tool that you can use to verify whether your solution procedure is correct. However, the actual results of the autocheck function (green check versus red ‘x’) do not count towards your grade.

The third component of homework is a written component. There will be problems distributed via PDF posted on the MITx site in addition to the automatically graded homework problems. Your homework score will be based on your written solution to the auto-check problems and the additional homework problems. Your written work for both the electronic problems and the written problems should be uploaded to the MITx site on the tab where the written homework PDF is located. Your files should have the naming convention \textit{lastName\_firstName\_psetNumber.fileExtension} (Example: Reif\_Rafael\_01.pdf).

You are encouraged to work together to help each other understand the homework. However, each student must turn in his or her own work. Copying solutions from others is prohibited. We believe doing the homework is the best method of preparation for the exams. Without independently understanding the method of solution of the homework, you will do poorly on the exams.

The written homework will be graded on a ternary scale (0/1/2) approximately corresponding to letter grades of F/C/A, respectively. However, the homework will be graded quickly and qualitatively. An “A”-equivalent grade on homework is not a good indicator of A-level performance on the exams because of this qualitative grading.

Your lowest homework score over the term will be dropped. You can use this dropped homework in the event of illness, busy schedule, or any other reason for not turning in one problem set. If you turn in all the problem sets, the lowest score will be dropped.