MAE 2030: Dynamics

Spring, 2017 Tuesdays and Thursdays 10:10 - 11:25 AM in Kimball B11

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TAs:

Head TA: Matt Sheen (mws262@cornell.edu)

HW Coordinator: Ilse Van Meerbeek (imv5@cornell.edu)

Bryan Peele (bnp26@cornell.edu) Ji Chen (jc3246@cornell.edu)

Emily Lederman (eel46@cornell.edu) Amlan Sinha (as2558@cornell.edu)

Graders:

Gregory Struble (grs94@cornell.edu) Hannah Klapper (hmk56@cornell.edu)

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Description. Newtonian dynamics of a particle, systems of particles, rigid bodies, simple mechanisms and simple harmonic oscillators. Impulse, momentum, angular momentum, work and energy. Two-dimensional (planar) kinematics including motion relative to a moving reference frame. Three dimensional rigid-body dynamics are introduced at the instructor's option. Setting up the differential equations of motion and solving them both analytically and numerically with MATLAB. In-lecture laboratory demonstrations illustrate basic principles.

Prerequisites. ENGRD 2020, MATH 2930, or permission of instructor. You should also have taken or be enrolled in MATH 2940 or equivalent. The following skills are assumed, and will *not* be covered in lecture (although you can always get help during office hours):

- Analytical integration of first-order ordinary differential equations (ODEs)
- Understanding of linear systems of ODEs
- Basic understanding of numerical integration of functions and ODEs
- Basic knowledge of scientific computing with MATLAB: writing scripts and functions, generating graphs from data, reading and fitting data
- (Towards the end of the semester) Basic matrix operations including transpose, inverse, matrix multiplication, and singular value decomposition

Appendices A through C of your textbook contain a review of all prerequisite knowledge.

Textbook. We will be using the textbook *Engineering Dynamics A comprehensive Introduction* by Kasdin & Paley. Note that there are two printings of this book. The earlier (2011) printing contains multiple errors that are corrected in the second printing. Up to date errata for both printings are available at:
http://cdcl.umd.edu/papers/kasdin-paley-errata.pdf

In addition to the campus store and other retailers, the book is also available online from the Cornell Library:
http://encompass.library.cornell.edu/cgi-bin/checkIP.cgi?access=gateway_standard%26url=http://lib.myilibrary.com?id=300143

Please note that the number of concurrent views and total views are limited for this resource and may run out during the semester. You should not rely on this as your only source for the text.

iClickers. We will make extensive use of iClickers for in-class quizzes and questions. **You must register your iClicker in Blackboard *before* the first lecture.** See: `http://pollinghelp.cit.cornell.edu/iclicker-with-blackboard/#student-info` for instructions. If your iClicker is not properly registered by the second week of classes, you will not receive credit for its use. *Note that REEF Polling will* ***not*** *be enabled for this course. You must use an iClicker.*

Recitations. *Recitations will start on Friday January 27th.* The recitation sections are not optional and attendance will be taken. The sections run on a Friday to Wednesday schedule. If you cannot attend your regular section email the head TA (`mws262@cornell.edu`) and request to attend another section during the same week (i.e., if your regular section is on Tuesday, then you must make it up by Wednesday of that week). Identify which alternate sections you can attend in your email. Please make an effort to schedule makeups as early as possible - do not wait until the last minute unless you are missing the recitation due to an emergency or illness. **If you show up at a section that you are not registered for without making previous arrangements with the head TA, you will not get credit for being there.**

The section times are:

Section	Day	Time	Location	TA
201	Wednesday	1:25 - 2:15pm	Thurston Hall 202	Bryan Peele
202	Wednesday	12:20pm - 1:10pm	Phillips Hall 407	Bryan Peele
203	Wednesday	9:05am - 9:55am	Olin Hall 216	Ilse Van Meerbeek
204	Wednesday	10:10am - 11:00am	Phillips Hall 407	Emily Lederman
205	Wednesday	12:20pm - 1:10pm	Hollister Hall 368	Matt Sheen
206	Wednesday	7:30pm - 8:20pm	Olin Hall 216	Amlan Sinha
207	Monday	12:20pm - 1:10pm	Phillips Hall 407	Ilse Van Meerbeek
208	Monday	12:20pm - 1:10pm	Hollister Hall 368	Emily Lederman
209	Friday	12:20pm - 1:10pm	Phillips Hall 407	Matt Sheen
210	Tuesday	9:05am - 9:55am	Olin Hall 216	Amlan Sinha
211	Monday	2:30pm - 3:20pm	Olin Hall 216	Ji Chen
212	Monday	3:35pm - 4:25pm	Olin Hall 216	Ji Chen

Homework Assignments. There will be weekly homework assignments. **All homeworks will be due on Fridays at 5pm**, unless otherwise stated. Assignments are to be turned in to the dropbox on the first floor of Rhodes. For any assignment due on a Friday, you may turn in your work by 5pm on the following Monday with an automatic deduction of 25% of the total points for the assignment. If an assignment contains both a written and MATLAB portion (see below), and you turn in either portion late by the Monday deadline, then you will only receive a 25% deduction on the part that you turned in late. **You may not split up the written portion, however.** If you have extenuating circumstances and wish to request an extension until the following Monday without loss of credit, you must email the HW coordinator (`imv5@cornell.edu`) at least 24 hours before the homework is due. All late assignments are to be turned in to the same dropbox as regular homeworks. **No assignments will be accepted after Monday at 5pm.** Occasionally, due to athletics or other university approved travel, you will be permitted to turn in your assignments electronically. You must get prior permission from the HW coordinator to do so, and the same deadlines apply. If approved, you must email your solution to `imv5@cornell.edu` **as a single PDF**, with all pages clearly legible. Other formats or multiple files will not be accepted. Homeworks emailed to anyone other than the HW coordinator will not be accepted.

You may discuss the homework problems with your classmates but **every student must submit an individual homework solution for each assignment and all work must be your own**. You must cite any and all external sources (anything other than lectures and the textbook) used in your solutions, and note the names of anyone with whom you discussed the assignments, including classmates and TAs. You will not lose credit for getting and citing such help but you must be clear about which parts of your presentation you did not do on your own. Violations of this policy are violations of the Cornell Code of Academic Integrity. Submitted work must be clear and legible, showing all steps of how you arrived at the solution as well as the solution itself. For computing portions of homework assignments, you may **not** submit code that is produced in groups (i.e., copies of the same code). Not all problems on all assignments will necessarily be graded in detail, but **you must still submit a solution for all assigned problems**. See the sample homework solution posted on Blackboard for detailed information on formatting.

Computing Assignments. Most of the homework assignments will include MATLAB computing portions. **All code will be submitted electronically, via Blackboard.** You will still need to turn in any portion of the problems that require derivation or discussion along with the remainder of each written homework assignment—the portion of the problem that is expected to be submitted via Blackboard will be clearly stated in the homework assignment. All code must be submitted in a single file for each assignment, which can be executed with no input arguments (an example will be posted to Blackboard). The file must be named as follows: 'HW' followed by the homework number followed by an underscore followed by your netid, followed by the '.m' extension. For example, the MATLAB portion of homework 1 for a student with netid as111 should be submitted as `HW1_as111.m`. **Failure to follow this naming convention may result in loss of points for that portion of the assignment.** Note that the MATLAB portion will be graded separately from the written portion—do not assume that the graders of the written portion will read through your code for the computing portion. You are also encouraged to test your code on one of the lab computers to ensure that there are no version conflicts and the code runs as expected.

A personal copy of MATLAB is recommended but *not* required. MATLAB is available in multiple computer labs around campus—to see which ones, go to `http://mapping.cit.cornell.edu/publiclabs/map/index.cfm`, expand the 'Engineering and Math' filters on the right-hand side, and select Matlab. You may purchase MATLAB either through the Cornell store (see `http://www.it.cornell.edu/services/software_licensing/available/matlab.cfm#buy`) or directly from Mathworks (`http://www.mathworks.com/academia/student_version/`). Note that the license purchased from Cornell is for one year only, whereas the one from the Mathworks is perpetual, but tied to a single MATLAB version. The two licenses may also come with different toolboxes, although you will only need the base MATLAB installation to complete your assignments.

All code used in lectures is available to you at `https://github.com/dsavransky/MAE2030`. If are not familiar with github and do not wish to learn, you can simply click the 'Clone or Download' button and select 'Download ZIP', which will download everything in the repository. To learn more about github, look here: `https://guides.github.com`.

Exams. There will be two prelims:

(1) 3/7/2016

(2) 4/18/2016

Room assignments for both exams will be posted to blackboard the week prior to the exam. You **must** take the exam in the room you are assigned to. Both prelims will be from 7:30 to 9:00pm and will be open note (both your notes and anything posted to Blackboard). No other resources (including the textbook or computers) will be allowed. For both prelims, there will be an early makeup session (from 5:30 to 7:15pm) offered on the same day as the scheduled prelim for those students with direct exam conflicts. **You must get prior permission to use these makeup sessions—email the head TA (`mws262@cornell.edu`) no later than one week prior to the exam.** You may not use these sessions unless you have a direct exam conflict or get special permission. You will be required to stay in the exam room for the entire exam period (until 7:15pm) - no exceptions will be made. If you are unable to make an exam or early makeup due to a medical or other emergency, you will have the opportunity to take a makeup in May (this will count for missing either of the prelims or the final). **If you know ahead of time that you will need to use the May makeup, email the head TA (`mws262@cornell.edu`) no later than one week prior to the exam you are going to be missing.** The final will be of the same format as the prelims, and will be held during finals week.

iClicker Quizzes. There will be an iClicker quiz during the first five minutes of each lecture with 3 to 5 multiple choice questions. Other iClicker questions asked during the lecture will not be graded. For each lecture, you will receive one point for each correctly answered quiz question, up to a maximum of two points, and three points for answering at least 75% of *all* questions asked during the lecture (for a total maximum of 5 points).

Students coming from across campus ($\geq$ 15 minute walk) or who have a direct lecture conflict are excused from iClicker quizzes, but must complete the quizzes that will be posted to Blackboard throughout the semester (approximately every 3 weeks). All students wishing to take advantage of this option **must notify me prior to the start of the semester via email**. The Blackboard quizzes are optional for all other students and may be taken for extra credit.

Grading. Your final grade will be determined as follows:

- 30% Homework assignments (lowest grade dropped)
- 10% iClicker Quizzes (lowest two dropped)
- 35% Prelim exams
- 20% Final exam
- 5% Section attendance (allowed to miss one) and TA evaluation

All grades will be posted to Blackboard as soon as an assignment is graded and returned. **It is your responsibility to check your grades online and to alert the head TA (`mws262@cornell.edu`) if any are missing or incorrect.** The Blackboard scores will be used to calculate your final grade so it is important to keep track of them throughout the semester. No regrade or score correction requests will be accepted after the last day of classes for any previously posted grades. If you do not have your iClicker properly registered by the second week of lectures, you will not receive any credit for the iClicker quizzes. The final score is calculated as:

$$T = 0.1\left(\frac{\sum_{i=1}^{n_c} c_i - \min_i(c_i) - \min_{i\notin \arg\min c_i}(c_i)}{5\left(n_c-2\right)}\right) + 0.3\left(\frac{\sum_{i=1}^{n_h} h_i - \min_i(h_i)}{\sum_{i=1}^{n_h} h_i^p - \mu(h_i^p)}\right) + 0.05\frac{s}{5} + 0.35\frac{P_1+P_2}{200}$$
$$+ 0.2\frac{F}{100} + 0.3\frac{h_e + \mathrm{EC}}{\sum_{i=1}^{n_h} h_i^p - \mu(h_i^p)} + \frac{0.3}{n_h}\left(\frac{\sum_{i=1}^{n_q} q_i}{\sum_{i=1}^{n_q} q_i^p} + \mathrm{NT} + \bar{m}\right),$$

where $\{c_i\}_{i=1}^{n_c}$ are the n_c iClicker scores, $\{h_i\}_{i=1}^{n_h}$ are the n_h regular homework scores, s is your section score (out of 5 points), $\{P_i\}_{i=1}^{2}$ are the prelim scores, F is the final exam score, h_e is the extra credit homework score, EC are any other extra credit points, $\{q_i\}_{i=1}^{n_q}$ are the n_q Blackboard quiz scores and NT is a boolean equal to one for note takers and zero otherwise. $\mu(\cdot)$ is the mean of a set of scores, and a p superscript indicates the number of points possible on a given assignment. The final term, m, represents extra credit given for significant improvement over the exams, and is calculated as:

$$m = \frac{1}{2}\left[\max\left(\bar{P}_2 - \bar{P}_1, 0\right) + \max\left(\bar{F} - \bar{P}_2, 0\right)\right] ,$$

where the overbars represent normalization by the exam means, and the max operators set each difference to zero if it is negative (so that there is no penalty for decreasing exam performance). The two terms in the summation are independently normalized by their maxima.

The numerical score will be converted to a letter grade by selecting the score of a group of students who I consider to be 'A','B' and 'C' performers, respectively, and then evenly splitting the numerical ranges about these values. The numerical score will be rounded to the nearest whole number for the purposes of assigning a letter grade. While the specific mapping will vary from year to year, in past years the minimum 'C-' score has tended to be around 60. This course is not curved to any assumed score distribution, and there is no pre-determined quota for the number of each letter grade to be assigned.

Extra Credit. Students may earn extra credit in the course by: volunteering to be a note taker, doing the blackboard quizzes (unless they have a lecture conflict, in which case the quizzes are mandatory and replace the iClicker scores), and reporting errors in the notes/lecture slides (instructions for this are posted in the relevant folders in blackboard).

Regrades. If you would like to request a regrade of an assignment, make a copy of it first. Do not make any changes to the original. Return your original assignment, along with a brief note describing where you believe points were incorrectly deducted, to your section TA, or during any office hours. No regrade requests or Blackboard score corrections will be accepted after the last day of classes.

Office Hours and Meetings. I will offer one hour, and each TA will offer two hours of office hours each week during the semester. The exact times will be posted to blackboard. **All office hours will be held in Thurston 102.** If you wish to request a private meeting outside of office hours, first check my public calendar (`https://www.google.com/calendar/embed?src=dsavransky%40gmail.com`) and then email me with **at least two** potential meeting times.

Academic integrity. Academic integrity is expected of all students of Cornell University at all times, whether in the presence or absence of members of the faculty. Violations of the code of academic integrity will be prosecuted through the Academic Integrity Hearing Board. For more information, see the following page on academic integrity: `http://cuinfo.cornell.edu/aic.cfm`

Students with Disabilities. Please give me your Student Disability Services (SDS) accommodation letter by the second week of the semester so that I have adequate time to arrange your approved academic modifications. You may request a private meeting by email to help ensure confidentiality. If you need an immediate accommodation for equal access, please speak with me after class or send an email message to me and/or SDS at `sds_cu@cornell.edu`. If the need arises for additional accommodations during the semester, please contact SDS. Remember that it is your responsibility

to notify me of the specific accommodation you wish to use no later than five days before any exam. See here for details: `http://sds.cornell.edu/Policies_Procedures/ProcAcad.html`

SCHEDULE

*Note: Readings refer to Kasdin & Paley chapters unless otherwise noted. Reading should be done **prior** to each lecture. Homework problems are from Kasdin & Paley, unless otherwise noted. This schedule may be periodically updated throughout the semester.*

Date	Topic	Reading	Homework
1/26	1. Introduction to Newtonian Mechanics; Newton's Laws; Constraints and Degrees of Freedom; Free Body Diagrams	2.1 - 2.4	HW 1 Due 2/3
1/31	2. Vectors; Reference Frames; Coordinate Systems; Vector Derivatives;	Appendix B, 1.1, 3.1 - 3.3	
2/2	3. Newton's 2nd Law Revisited; More Coordinate Systems; How to Solve a Dynamics Problem; Numerical Integration	2.2, 3.1 - 3.3, 3.7, Appendix C	HW 2 Due 2/10
2/7	4. Simple Harmonic Oscillators; Damped Harmonic Oscillation; Mass-Spring-Damper Systems; In-Class Demo 1	Tutorial 2.3 - 2.4	
2/9	5. Rotating Frames; Angular Velocity	3.4	HW 3 Due 2/17
2/14	6. Fictional Forces and Relative Motion	3.5 - 3.6	
Blackboard Quiz 1 Due 2/15			
2/16	7. More on Angular Velocity and Vector Derivatives; Other Forces	3.4, 3.8, 2.6	HW 4 Due 2/24
2/18 - 2/21 February Break. No sections 2/17 - 2/22			
2/23	8. Linear and Angular Momentum and Impulse	4.1 - 4.2	HW 5 Due 3/3
2/28	9. Work; Power; Kinetic, Potential and Total Energy	5.1 - 5.5	
3/2	10. Pulleys; Simple Machines; Mechanical Advantage	5.1 - 5.5	
3/7	11. Multiparticle Systems; Center of Mass; Motion Relative to Center of Mass;	6.1	HW 6 Due 3/17
3/7 Prelim 1 - Chapters 1 - 5			
3/9	12. Coupled Oscillators; In-Class Demo 2	12.1	
3/14	13. Impacts and Collisions	6.2, 12.3	
Blackboard Quiz 2 Due 3/15			
3/16	14. Angular Momentum of Multiparticle Systems	7.1 - 7.3	HW 7 Due 3/24
3/21	15. Work and Energy of Multiparticle Systems	7.4	
3/23	16. The Transport Equation	8.1 - 8.3	HW 8 Due 3/31

3/28	17. Rolling and Gears	8.1	
3/30	18. Linkages; In-Class Demo 3	8.4	HW 9 Due 4/14
	4/1 - 4/9 Spring Break		
4/11	19. Rigid Bodies; Euler's Laws; Moment of Inertia	9.1 - 9.3	
	Blackboard Quiz 3 Due 4/12		
4/13	20. More on Rigid Bodies; Moment Transport; Parallel Axis Theorem	9.4	HW 10 Due 4/28
	4/18 Prelim 2 - Chapters 1 - 8		
4/18	21. Rigid Body Work and Energy; Collections of Bodies and Particles	9.5 - 9.6	
4/20	22. 3D Coordinate Systems	10.1 - 10.2	
4/25	23. 3D Kinematics	10.3 - 10.4	
4/27	24. Euler's Laws in 3D; Review of Tensors; Moment of Inertia Tensor	11.1 - 11.2; Appendix B & D	HW 11 Due 5/5
5/2	25. Spinning Rigid Bodies; Moment Transport and Parallel Axis Theorem in 3D; In-Class Demo 4	11.3 - 11.4	
5/4	26. Torque Free Motion; Rotating the Moment of Inertia Tensor; Impulse, Work and Energy in 3D	11.5 - 11.7	Extra Credit Homework Due TBD
5/9	27. Final Review/Introduction to Analytical Mechanics		
	Blackboard Quiz 4 Due 5/10		