MAE 506: Advanced System Modeling, Dynamics and Control
Syllabus for Fall 2015

Lecture: Tuesday/Thursday 3:00-4:15pm, BYAC (Brickyard) 110

Class Website: Course materials will be posted on the ASU Blackboard system (https://myasucourses.asu.edu or http://my.asu.edu). Materials to be posted include announcements, assignments, solutions to assignments, and lecture notes. Course announcements will also be sent via email.

Instructor: **Prof. Spring Berman**

Contact Info: E-mail: spring.berman@asu.edu
Office: Engineering Research Center (ERC) 375
Office phone: 480-965-4431

Office Hours: Monday/Wednesday 1:30pm-3:00pm in ERC 375
Other times by appointment (schedule by e-mail to spring.berman@asu.edu)

Required Text: **Robert L. Williams II and Douglas A. Lawrence. Linear State-Space Control Systems.** John Wiley & Sons, Inc., 2007. (ISBN-10: 0471735558, ISBN-13: 978-0471735557)

Electronic version of the book is available at:
http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471735558.html

Additional Useful References:

K. Ogata, Modern Control Engineering, 5th ed., 2010
G. F. Franklin, J. D. Powell, and A. Emami-Naeini, Feedback Control of Dynamic Systems, 7th ed., 2014
R. C. Dorf and R. H. Bishop, Modern Control Systems, 12th ed., 2010.
F. Golnaraghi and B. C. Kuo. Automatic Control Systems, 9th Edition. John Wiley & Sons, Inc., 2009.
N. S. Nise, Control Systems Engineering, 6th ed., 2010
W. Palm, Modeling, Analysis, and Control of Dynamic Systems, 2nd ed., 1999
W. L. Brogan, Modern Control Theory, 3rd ed., 1990
C.-T. Chen, Linear System Theory and Design, 3rd ed., 1999
J. P. Hespanha, Linear Systems Theory, 2009
A. Sinha, Linear Systems: Optimal and Robust Control, 2007
K. J. Astrom and R. M. Murray, Feedback Systems, 2012
(Available at: http://www.cds.caltech.edu/~murray/amwiki/Main_Page)
B. Friedland, Control System Design: An Introduction to State-Space Methods, 2005
P. R. Belanger, Control Engineering: A Modern Approach, 1995
W. J. Rugh, Linear System Theory, 2nd ed., 1996
A. Tewari, Modern Control Design with MATLAB and SIMULINK, 2002.
(Available as an ASU NetLibrary Electronic Book:
http://library.lib.asu.edu/search~S3?/aTewari%2C+Ashish./atewari+ashish/1%2C1%2C2%2CB/frameset&FF=atewari+ashish&2%2C%2C2/indexsort=-)

Software: MATLAB is available at Citrix: http://citrix.asu.edu

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Course Description: Lumped-parameter modeling of physical systems with examples. State variable representations and dynamic response. Introduces modern control.

Course Objectives: Students will learn how to model physical systems; how to design feedback control systems; and how to conduct time-domain and frequency-domain analyses of these systems. Students will also be introduced to topics in state-space methods including controllability, observability, observers, and design of linear state feedback control laws. Students will be required to use MATLAB to solve problems throughout the course.

Enrollment Requirements: Must take MAE 501: Linear Algebra in Engineering concurrently or have completed this class (or an equivalent class) with a grade of C or higher. Graduate engineering students and motivated upper-level undergraduate engineering students may enroll. Prior knowledge of control systems and MATLAB is useful, but not required.

Homework:

- There will be 8 homework assignments throughout the semester. Homework should be turned in **at the beginning of class** on the due date.
- **Unless a student has obtained special permission for extraordinary circumstances, late homework assignments will not be accepted**.

Exams:

Midterm exam: October 8 during regular class time. The exam is closed-book and closed-notes. One double-sided handwritten cheat sheet (11 in. × 8½ in.) is allowed.

Final exam: Sometime during December 7-12, location TBD. The exam is closed-book and closed-notes. Three double-sided handwritten cheat sheets (11 in. × 8½ in.) are allowed.

- For the purposes of fairness, it is important that all students take the same exam at the same time. **Unless a student has obtained special permission for extraordinary circumstances, make-up exams are not allowed.**
- Midterm exam rescheduling requires instructor permission. Final exam rescheduling requests must be made through the Dean's Office as soon as a scheduling conflict is known.

Grading Policy:

- After graded work is returned to students, no grading inquiry will be considered for 24 hours. After that period, students have **one week** from the day that their work is returned to contact the instructor regarding the grading of a specific homework assignment or exam. After the one-week period, no grading inquiry will be considered. Please note that by contesting the grading of a homework assignment or test, you are agreeing that the entire assignment or test is subject to be re-graded.

- Students are responsible for checking the Blackboard website to make sure that it has the correct grade information. Students are encouraged to keep all graded assignments since grades cannot be corrected without physical proof that an error was made.

- After the final exam, no request for a grade upgrade will be considered. Students are responsible for earning their final grade.

- **Grade of Incomplete:** An "incomplete" may be awarded only in cases when a student, who is otherwise performing satisfactorily, cannot complete final course requirements, such as a final exam or final project, due to circumstances beyond the student's control (such as illness or family emergency). Such circumstances must be documented. The student must have completed most of the course requirements. Incompletes will be approved only within the last one or two weeks of the semester and, in any case, never prior to the final semester withdrawal date. Incompletes cannot be requested after the time of the scheduled final exam for the course. To request a grade of incomplete, the student must formally apply to the instructor using the university's "Incomplete Grade Request" form. Requests must be submitted to the student's advisor prior to the final grade due date and are subject to final approval by the program.

Composition of course grade:

Homework and class participation	40%
Midterm	25%
Final exam	35%

Letter grade rubric:

(Note: these are approximate boundaries between grades)

A+:	≥ 95
A:	≥ 85 and < 95
A-:	≥ 80 and < 85
B+:	≥ 77.5 and < 80
B:	≥ 72.5 and < 77.5
B-:	≥ 70 and < 72.5
C+:	≥ 67.5 and < 70
C:	≥ 60 and < 67.5
D:	≥ 50 and < 60
E:	< 50

Academic integrity policy:

- Cheating on homework and exams is **unacceptable**. While students may discuss homework assignments with each other, the work that each student submits must be entirely his/her own. Plagiarism is the submission of unreferenced content that was not the product of your original thought but which you are claiming as your own. Group homework, including writing and submitting multiple copies of communal MATLAB code, is not allowed.
- Copying on the homework will result in a **zero** for the homework portion of the total grade; cheating on an exam will result in an **E** for this class. Suspected cases of academic dishonesty will be reported to the Office of Academic and Student Affairs. See the ASU Academic Integrity Policy at http://provost.asu.edu/academicintegrity for more details.

Other Notes:

- Students are expected to regularly attend lectures and are advised to take advantage of office hours. Please schedule an appointment with me during office hours if you have any questions, concerns, or if you have a disability that will require accommodations during this class.
- Absences will be excused for: (a) official university-recognized religious holidays (see ACD 304-04); (b) university-sanctioned events and activities (see ACD 304-02), such as participating in officially recognized sporting events and representing ASU at student conferences. In these cases, students will be given the opportunity to make up exams and other graded work. The university requests that students who are ill remain away from campus in order to prevent the spread of infectious disease. Students with documented illness will be given alternative grading options.
- Use of cell phones is not permitted in the classroom. Recording devices are allowed, but please note that lectures and other course content are copyrighted materials. Students may not sell notes or recorded content taken during the course.
- Disruptive or threatening behavior will be handled according to Section 104-02 of the Student Services Manual. All incidents and allegations of violent or threatening conduct by an ASU student (whether on- or off-campus) must be reported to the ASU Police Department and the Office of the Dean of Students.
- Students requesting accommodations for a disability, including additional time or resources for taking exams, must be registered with the Disability Resource Center (DRC, http://www.asu.edu/studentaffairs/ed/drc/, Phone: 480-965-1234; TDD: 480-965-9000) and submit appropriate documentation from the DRC to me.
- Information in this syllabus, other than grade and absence policies, may be subject to change with reasonable advance notice.

MAE 506 Schedule – Fall 2015

- **Text**: Linear State-Space Control Systems, by Robert L. Williams II and Douglas A. Lawrence
- **Lecture notes**: Electronic copies will be provided on Blackboard

#	Date	Topics	Reading	Assignment
1	Aug. 20	Syllabus, intro to control systems, system model classification, differential equations	1.1, notes	
2	Aug. 25	Complex variables, Laplace transforms, transfer functions	Notes	HW 1
3	Aug. 27	Transfer functions, solving ODEs, MATLAB	1.5, notes	
4	Sept. 1	State space realizations, block diagrams, MATLAB	1.2, 1.5, pp. 14-17	
5	Sept. 3	Linearization of nonlinear systems	1.4	HW 1 due; HW 2
6	Sept. 8	Modeling of mechanical systems	Examples 1.1-1.4, 1.6	
7	Sept. 10	Modeling of mechanical systems	Examples 1.1-1.4, 1.6	
8	Sept. 15	State space fundamentals	pp. 48-72	HW 2 due; HW 3
9	Sept. 17	State space fundamentals	pp. 48-72	
10	Sept. 22	Coordinate transformations, diagonal canonical form	2.5, Appendices B.4, B.6	
11	Sept. 24	Time response of LTI systems	Notes	HW 3 due; HW 4
12	Sept. 29	Time response of LTI systems, Root locus method	Notes	
13	Oct. 1	Root locus method	Notes	HW 4 due
14	Oct. 6	Review for midterm exam	Notes	
	Oct. 8	**In-class midterm on material from Lectures 1-14**		
	Oct. 13	**No class – Fall Break**		
15	Oct. 15	Frequency response method, Bode plots and Nyquist plots	Notes	
16	Oct. 20	Bode plots and Nyquist plots, Stability margins	Notes	HW 5
17	Oct. 22	PID control, Controllability	Ch. 3, Notes	
18	Oct. 27	Controllability	Ch. 3	
19	Oct. 29	Controllability, Observability	Ch. 3-4	HW 5 due; HW 6
20	Nov. 3	Observability, Minimal realizations	Ch. 4-5	
21	Nov. 5	Internal stability analysis	Ch. 6	
22	Nov. 10	Internal stability analysis	Ch. 6	HW 6 due; HW 7
23	Nov. 12	BIBO stability analysis; Design of linear state feedback control laws	Ch. 6-7	
24	Nov. 17	Design of linear state feedback control laws	Ch. 7	
25	Nov. 19	Observers and observer-based compensators	Ch. 8	HW 7 due; HW 8
26	Nov. 24	Observers and observer-based compensators, Intro to linear quadratic regulator (LQR) optimal control	Ch. 8, pp. 357-360	
	Nov. 26	**No class – Thanksgiving**		
27	Dec. 1	LQR optimal control	pp. 357-360, notes	
28	Dec. 3	Review for final exam	Notes	HW 8 due