Syllabus
MAE 207 – Model Reduction (Spring 2020)

Synopsis: High-dimensional systems abound in engineering and science, as they arise in modeling of biological processes, when discretizing partial differential equations (of fluids, solids, magnetic fields, etc.), and in mechanical systems with thousands of degrees of freedom. Reduced-order modeling provides the mathematical tools, theory and algorithms to reproduce and predict behaviors in complex systems without doing the direct (and expensive) simulation of the full-order model. As such, reduced-order models are important in long-time prediction, control, uncertainty quantification and computational design. This course covers a wide range of model reduction techniques and their underlying theory: System-theoretic approaches such as balanced truncation, transfer-function interpolation, and controller reduction techniques; Projection-based approaches such as proper orthogonal decomposition and reduced-basis methods; and data-driven approaches such as dynamic mode decomposition and Loewner-based system identification.

Course Coordinator: Dr. Boris Kramer (bmkramer@ucsd.edu)

Teaching Assistant: Mr. Li Tan (ltan@eng.ucsd.edu)

Class schedule: TuThu 9:30a – 10:50a PST (San Diego Time)

Zoom Class Info: Before the first class, you need to register at:
https://ucsd.zoom.us/meeting/register/u5Qofuyhqzsq U4aUkHKPXb0fcBzm72E_xQ.
Once registered, you can use https://ucsd.zoom.us/j/605959500 every time to join class.
Class sessions will be also recorded and made available to students asynchronously (available in Canvas within 24h of recording)

Zoom office Hours: Thu 11a – 12.30p (Boris Kramer, Zoom personal meeting room, Password: ROM)
https://ucsd.zoom.us/j/3503488571?pwd=R0E3UmliV3YrSGtvTUJ3a2cxMXF5QT09

Wed 10a – 11:30a (Li Tan) https://ucsd.zoom.us/j/546616357

Prerequisites: MAE280A, MAE290A, MAE283A or consent of instructor. MATLAB will be used as the standard computing environment and proficiency is required.

E-mail communication: In an e-mail to instructor or TA please put "MAE207" **first** in the subject line.

Textbooks/Materials: We will draw topics from a wide range of journal articles and several textbooks. They are excellent resources, but not required.

1. Antoulas, A.C., Beattie, C.A., Gugercin, S.: Interpolatory methods for model reduction. Computational Science and Engineering Series. SIAM (2020) https://doi.org/10.1137/1.9781611976083
2. JS Hesthaven, G Rozza, B Stamm, Certified reduced basis methods for parametrized partial differential equations. Springer (2016) https://hal.sorbonne-universite.fr/hal-01223456/document
3. Antoulas, A. C. Approximation of large-scale dynamical systems. Vol. 6. SIAM, 2005. https://doi.org/10.1137/1.9780898718713
4. Kutz JN, Brunton SL, Brunton BW, Proctor JL. Dynamic mode decomposition: data-driven modeling of complex systems. SIAM, 2016 https://doi.org/10.1137/1.9781611974508
5. P. Benner, M. Ohlberger, A. Cohen, K. Willcox. Model Reduction and Approximation: Theory and Algorithms. SIAM 2017.https://doi.org/10.1137/1.9781611974829

Homework: This is a very important part of this course. There will be a homework assignment about every two weeks, for a total of 4-5. You can work together on homework problems, but your final write up must be your own work, done independently. Homework has to be turned in on-time, no late assignments will be accepted under any circumstances.

Term Project: Various potential subjects for term project will be provided. However, students are strongly encouraged to propose their own ideas for a term project, that would connect/apply model reduction to their research area. However, approval for term project proposals is not automatic. A clear connection to the class material needs to be established. Details of the term project requirements and expectations will be discussed during the semester. Teams of two students are also possible, but the term will then be more comprehensive than just a single student project.

Grading:

Homework	50%
Term Project	50%

A 90% will guarantee an A-, 80% a B-, 70% a C- and 60% a D.
Re-grade requests need to be made within 48h of the return of the assignment. Appeals outside of this time frame will not be considered.

Missing a graded assignment: If for a documented reason you cannot turn in your homework or final project, your remaining grades will determine your final grade. For instance, if you miss the final project for a documented reason, the homework grade will be your final grade. If you miss one homework, then the remaining N-1 homework results will determine your homework grade.

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Last Updated: March 26, 2020. The course coordinator reserves the right to change the syllabus at any time.