



THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON DC

Syllabus

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SPRING 2015
Office hours:
Mon. & Tues. 4–6 P.M.

MAE 6258 ADVANCED VIBRATION ANALYSIS AND CONTROL 3 credits

PREREQUISITES

MAE 3134 (or equivalent) and MAE 4182 (or equivalent)

Ordinary differential equations, linear system modeling (transfer function and state space), classical control theory (root locus, Routh-Hurwitz and Nyquist stability criteria, etc.), statistics, basic MATLAB programming

EDUCATIONAL OBJECTIVES

To present techniques for dynamic analysis and control design in the time and frequency domains for vibrating systems, including modeling procedures, sensor and actuator placement, and feedback control synthesis. By the end of the course, the student will be able to:

1. Apply force/moment/energy balances to derive EOMs for SDOF/MDOF systems
2. Describe the important properties of transient, steady-state, free, and forced responses
3. Develop analytical and computational solution procedures
4. Compute statistical information regarding random vibration response
5. Design passive vibration suppression systems
6. Use classical control techniques (root locus, frequency response) for active vibration suppression

COURSE TOPICS

1. Passive vibration control of SDOF systems: tuning, balancing, and dynamic vibration absorbers
2. Active vibration control of SDOF systems using root locus and frequency response techniques
3. Modal analysis and control of MDOF and continuous systems: effects of sensor and actuator placement
4. Random vibrations: analysis and control, failure prediction
5. Realization and system identification
6. Nonlinear vibrations

MEETING TIMES

lecture: Wednesdays 12:45pm–3:15pm, SEH 3040

GRADING

Homework and projects: 60% (roughly 10 assignments)
Mid-term exam: 20% (mid March)
Final exam: 20% (mid May)

Homework is collected at the beginning of lecture on the due date (with some exceptions). Homework can be turned in late at my office until 5 pm the following weekday, with a 20% penalty. No homework is

accepted after that, as solutions will be posted at that time. With extenuating circumstances, homework extensions can be provided and exams can be made up or rescheduled if approved beforehand by the instructor. A missed exam with no approved excuse can be made up within one week, with a 20% penalty.

Re-grade requests must be submitted at the end of lecture on the class immediately following the return of the graded material or brought to office hours to discuss. A justification must accompany any re-grade request. Simple re-grade requests (e.g. adding errors, multiple deductions) are accepted anytime. It is possible for a grade to be lowered after a re-grade.

Grades are not curved in this course. It is theoretically possible for everyone in the class to get an A (or an F). Your grade depends only on your own performance, not on how well everyone else does. Adjustments or supplements may be made to homework or exam grades if they prove to be unfairly difficult. Grades may also be adjusted due to outstanding attitude and effort. Extra credit is not given on an individual basis, and all grades are final.

ACADEMIC INTEGRITY

Students can work collaboratively on homework and projects in order to learn together but homework submission should reflect an individual effort. Strict copying is not permitted. Exams must reflect only your individual effort. Only materials permitted by the instructor are allowed to be used during the exams.

TEXTS (OPTIONAL)

Ogata, *System Dynamics*, 4th Edition, Prentice Hall (linear system dynamics)
Nice, *Control Systems Engineering*, 6th Edition, Wiley (classical controls)
Inman, *Engineering Vibration*, Pearson (modal analysis)
Lin, *Probabilistic Theory of Structural Dynamics*, Krieger (random vibrations)
Pratap, R., *Getting Started with MATLAB* (Matlab programming)

ATTENDANCE

Students are expected to attend every lecture, and they are responsible for all course material and announcements discussed in class. Students are encouraged to avoid attending lecture if they are ill and/or contagious. Please inform the instructor as soon as possible if you must miss class due to illness. Other reasons for absence must be communicated to the instructor ahead of time and approved. Notes written on the board will not be posted.