

ME 5990

Machining Dynamics

General Course Information

Fall 2004

Instructor

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Who am I? I grew up in the Northwest suburbs of Chicago (Park Ridge). I attended the University of Illinois at Urbana-Champaign where I received my B.S. (1988), M.S. (1990) and Ph.D. (1992) degrees, all in Mechanical Engineering. I spent 7 years at U. of Michigan before coming to MTU in 2001. In addition to my university employment, I have a small business, Machining Analysis Technologies, LLC, through which I help companies solve short-term problems, provide educational short courses to help companies better understand their machining processes and how to select cutting tool, and develop new and innovative manufacturing technologies. Besides my work, I do have other interests, such as broomball, ice hockey, roller hockey, camping, and listening to music. I have three children.

Office: Location: 920 R. L. Smith
Phone: 487-2567
Regular Hours: Tuesday, 3:00 p.m. – 5:00 p.m.
Thursday, 1:30 p.m. – 2:30 p.m.
Other Hours: By appointment, or anytime I am in my office
and my **door is open**. But, **not right before class** from 3:00 – 4:00 p.m.; thanks.

Home: Phone: (906) 370-1442
Hours: 8 a.m. – 5 p.m. (7 p.m. – 10 p.m. **if urgent**)

Course Format

Lecture: Time: W, 4:05 – 5:20 p.m.; 5:45 – 7:00 p.m.
Homework: Assigned in coordination with lecture and due one or two weeks later.
Paper Presentations: Over the term, each student will present two of the papers provided for reading, which will serve as supplementary lectures.
Quizzes: Every other Session A.
(each answer which has something to do with the question's topic will get credit)

Grading

HW Assignments (4) Total:	40%
Paper Presentation (2.5) Total:	25%
Quizzes (best 4 of 5) Total:	5%
Final Project:	30%

Assignment Preparation, Submission and Re-grade Policy

Preparation: Assignments (homework, laboratory and projects) will be assigned either to each individual student or, in some cases such as laboratory reports, to a pre-defined team. All assignments are to be completed by the individual or team per the assignment. The term 'You' in the following refers to either an individual student or a team of students for team assignments.

You are allowed and encouraged to consult with other students in the current class during the solution of assignments; but all final written and computer work is to be generated by you

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working alone. You are not allowed to transcribe the work, either in scrap or final form, of another student; you are expected to work out the details of the assignments on your own when producing the final document to be submitted for grade. You are also not allowed to possess, look at, use, or in anyway derive advantage from the existence of solutions prepared in prior years, whether these solutions were former students' work product or copies of solutions that had been made available by an instructor.

Violation of this policy is grounds for the instructor to initiate a disciplinary action. If you have any questions about this policy, **please** do not hesitate to contact me.

Submission: All assignments are due in class on the due date, unless otherwise stated. It is preferred that the assignment be submitted at the start of class. Assignments turned in after I leave lecture but before 8:00 a.m. the following morning will be accepted with a 25% penalty. Assignments submitted later than that but before the end of the next day will be graded if you want, but will not receive credit.

Re-grade: Any request for re-grade (homework assignments, quizzes, laboratory/project reports, exams, etc.) must be made/submitted within one (1) week of when the graded work is returned with the original grade, no exceptions.

Course Goals

1. Understand sources of mechanical energy and energy transfer within the machining system.
2. Be able to analyze for the dynamic response and stability of a machine-tool system.
3. Understand assumptions required for analyses and the resulting limitations.
4. Be familiar with and understand the mechanisms unique to variable-speed and high-speed machining.
5. Be able to develop a time-domain dynamic simulation of a machining process or a mechanism within (project).

Course Outline

Part 6 may not be covered due to insufficient time.

1 Introduction to Advanced Machining Analysis	4 Real Tooling, Processes and Structures
1.1 Mechanics versus Dynamics	4.1 Accounting for Size-Effect Nonlinearity
1.2 Review of the Ideal Chip Formation Model	4.2 Effects of Corner Radius – Turning
1.3 Nonlinearities in Machining	4.3 Accounting for Periodic Time Variation
1.4 Review of Steady-State Dynamics Analysis	4.4 Effects of Multiple Teeth and Multi-D Dynamics
1.5 Machining Dynamics Problems	4.5 Real Multi-Tooth, Time Varying Processes – Boring and Milling
2 A Structured Dynamic Model for Orthogonal Cutting	5 The Cutting Process Damping Mechanism
2.1 A Single-Tooth, 1-D, LTI Model	5.1 Linear Penetration Rate Model
2.2 Process Orientations	5.2 Linear Effective Clearance Angle Model
2.3 Feedback Mechanisms and Phase Shifts	5.3 Penetration Volume Model
2.4 Stability and Energy Considerations	5.4 Practical Issues — Modeling vs. Matching
3 Linear Time-Invariant Stability Analysis of Machining	6 Vibration Analysis Solutions
3.1 Traditional Frequency-Domain Approach	6.1 Chatter Vibration Level – Linear Process
3.2 Eigenvalue Problem Approach	6.2 Chatter Vibration Level – Nonlinear Process
3.3 Energy-Based Approach	6.3 Forced Vibration Level
3.4 Evaluation of the Single-Tooth, 1-D, LTI Assumption	