

ME 5990

Machining Dynamics

Course Schedule

Fall 2004

Day (#)	Topic	Description	# Lec.	Assignments
W 09/01A (1)	Course Information 1.1 Mechanics versus Dynamics 1.2 Review of the Ideal Chip Formation Model	Format, grading, policies, honor code, goals Their difference and the link between them Orthogonal process geometry and velocities	1/5 2/5 2/5	Assign Paper Set 0 Reading (Chapters 2 and 8.4 of ME 5610 Notes)
W 09/01B (2)	Arrange paper presentations 1.2 Review of the Ideal Chip Formation Model, cont'd	Orthogonal force-geometry relations Strain and energy Ideal vs. reality — concepts and assumptions	1/5 2/5 1/5 1/5	
W 09/08A (3)	1.2 Review of the Ideal Chip Formation Model, cont'd 1.3 Nonlinearities in Machining	Ideal vs. reality — experimental images Size effect	2/5 3/5	Assign HW1 Assign Paper Set 1 Reading
W 09/08B (4)	1.3 Nonlinearities in Machining, cont'd 1.4 Review of Steady-State Dynamic Analysis	Process damping The chatter condition Frequency-response Linear stability analysis	1/5 1/5 2/5 1/5	
W 09/15A (5)	Quiz 1 Paper Presentation 1a Paper Presentation 1b	Historic Graphical Techniques for Machining Stability Analysis	1/5 2/5 2/5	
W 09/15B (6)	1.5 Machining Dynamics Problems	Stability-limit diagrams — general characteristics Stability-limit diagrams — speed measured Vibration-level diagrams — unstable/chatter Vibration-level diagrams — stable/forced	1/5 2/5 1/5 1/5	<i>HW1 Due</i>
W 09/22A (7)	1.5 Machining Dynamics Problems, cont'd	High-speed machining (HSM) Variable-speed machining (VSM)	3/5 2/5	Assign Paper Set 2 Reading
W 09/22B (8)	2.1 A Single-Tooth, 1-D, LTI Model	The physical model Time-domain representation	2/5 3/5	
W 09/29 (9)	Quiz 2 Paper Presentation 2a Paper Presentation 2b	Analytical Stability Solutions for 1-D, Linear, Time-Invariant Machining Processes	1/5 2/5 2/5	Assign HW2
W 09/29 (10)	2.1 A Single-Tooth, 1-D, LTI Model, cont'd 2.2 Process Orientations	Frequency-domain representation C-axis rotation	2/5 3/5	
W 10/06 (11)	2.2 Process Orientations, cont'd	L-axis rotation Why break down the model into so many pieces?	3/5 2/5	

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W 10/06	(12)	2.3 Feedback Mechanisms and Phases Shifts	Block diagram representation Phases and frequencies	3/5 2/5	
W 10/13	(13)	2.4 Stability and Energy Considerations	Review of definitions of stability Energy interpretations	3/5 2/5	Assign Paper Set 3 Reading
W 10/13	(14)	3.1 Traditional Frequency-Domain Approach	Vibration growth approach Nyquist approach with arbitrary overlap factor	2/5 3/5	<i>HW2 Due</i>
W 10/20	(15)	Quiz 3 Paper Presentation 3a Paper Presentation 3b	Nonlinearities — Structural Dynamics, Size Effect and Process Geometry	1/5 2/5 2/5	Assign HW3
W 10/20	(16)	3.1 Traditional Frequency-Domain Approach, cont'd 3.2 Eigenvalue Problem Approach 3.3 Energy-Based Approach	Solution for unity overlap factor Basic algebra for 1-D case A quantitative time-domain approach	1/5 2/5 2/5	
W 10/27	(17)	3.3 Energy-Based Approach, cont'd 3.4 Evaluating the LTI Assumption	Structural energy / process energy Total energy and stability limit Comparison to Tlusty's frequency-domain solution Where the 'L' and 'TI' are lost — intermittency and/or kinematics	2/5 1/5 1/5 1/5	Assign Paper Set 4 Reading
W 10/27	(18)	4.1 Accounting for Size-Effect Nonlinearity 4.2 Effects of Corner Radius – Turning	Basic linearization of process force The orthogonal equivalent for corner-radiused tooling Corner radius background	2/5 2/5 1/5	Assign Final Project
W 11/03	(19)	Quiz 4 Paper Presentation 4a Paper Presentation 4b	Periodic Time Variation — Intermittency and Kinematics	1/5 2/5 2/5	<i>HW3 Due</i>
W 11/03	(20)	4.2 Effects of Corner Radius – Turning, cont'd	Effect of displacements on chip area An analytical chip area formulation	1/5 4/5	<i>Draft Final Project Proposals Due</i>
W 11/10	(21)	4.2 Effects of Corner Radius – Turning, cont'd	Linearization of chip area nonlinearity Stability solution	2/5 3/5	Assign Paper Set 5 Reading
W 11/10	(22)	4.3 Accounting for Periodic Time Variation	Basic intermittent orthogonal process Traditional time-averaging approach Traditional time-averaging approach, cont'd Added stability lobes	1/5 1/5 1/5 2/5	<i>Final Project Proposals Due</i> Assign HW4
W 11/17		Cancelled for ASME IMECE			
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W 11/25		Thanksgiving	Relax and Enjoy!!		
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Day	(#)	Topic	Description	# Lec.	Assignments
W 12/01	(23)	Quiz 5 Paper Presentation 5a Paper Presentation 5b	Milling Stability	1/5 2/5 2/5	
W 12/01	(24)	4.3 Accounting for Periodic Time Variation, cont'd 4.4 Multiple Teeth and Multi-D Dynamics	Effects of key parameters Problem classification Multi-tooth cancellation of dynamic force time variation Multiple-solutions for multi-D – the eigenvalue problem	2/5 1/5 1/5 1/5	
W 12/08	(25)	4.5 Real Multi-Tooth, Time Varying Processes – Boring and Milling	3-D equation of motion for boring process Boring solution Milling geometry	2/5 2/5 1/5	Assign Paper Set 6 Reading
W 12/08	(26)	4.5 Real Multi-Tooth, Time Varying Processes – Boring and Milling, cont'd	Milling geometry, cont'd Kinematic equations for forcing function Time varying directional gains	2/5 1/5 2/5	<i>HW4 Due</i>
M 12/13		All Done!			<i>Final Project Due by 9:00 a.m.</i>