THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Print

Form Number 1449

Action Requested

(•) New Course
( ) Modification of Existing Course
( ) Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 10/4/2004
Effective Winter 2005

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department / Div # / Course Number	Home Department: Mechanical Engineering / Course Number: 569
Cross Listed Course Information	Cross Listed Course Information
Course Title	Course Title: Control of Advanced Powertrain Systems
TITLE ABBREVIATION — Time Sched Max = 19 Spaces	Adv Powertrain Sys
TITLE ABBREVIATION — Transcript Max = 20 Spaces	Adv Powertrain Sys
Course Description	Course Description for Official Publication (Max = 50 words): Will cover essential aspects of electronic engine control for spark ignition (gasoline) and compression ignition (diesel) engines followed by recent control developments for direct injection, camless actuation, active boosting technologies, hybrid-electric, and fuel cell power generation. Willl review system identification, averaging, feedforward, feedback, multivariable (multiple SISO and MIMO), estimation, dynamic programming, and optimal control techniques.
PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k	**PROGRAM OUTCOMES:** ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k
Degree Requirements: ○ Degree Requirement ○ Core Course ○ Free Elective ○ Tech Elective ○ Other	Degree Requirements: ○ Degree Requirement ○ Core Course ○ Free Elective (•) Tech Elective ○ Other
Prerequisites: ○ Enforced ○ Advised	Prerequisites: ME360; P/A ME461 ○ Enforced (•) Advised
Credit Restrictions	Credit Restrictions
Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Worl; Credit Hours Min / Max; Contact Hrs/Wk; Number of Wks	Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☒ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min 3 / Max 3; Contact Hrs/Wk 3; Number of Wks 14
C. Repeatability (Indl Research, Dir. Study, Dissertation): Is this course repeatable? ○ Yes (•) No; Maximum Hours? ___ Maximum Times? ___; Can it be repeated in the same term? ○ Yes (•) No	Printing Information (Optional): ☒ Print the course in the Bulletin ☐ Print the course in the Time Schedule
Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other ___; Graded Section: (•) Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other; Grading: ☒ A-F ☐ CR/NC ☐ S/U ☐ P/F ☐ Y; Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension	Terms & Freq. of Offering: ☐ I ■ II ☐ IIIa ☐ IIIb ☐ III; ■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years; Half term ☐ 1st ☐ 2nd
	Cognizant Faculty Member: A. Stefanopoulou; Title: Assoc. Prof.
	Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval

☐ Curriculum Comm. ___
☐ Faculty ___
☐ Rackham ___
☐ Cross listed Unit 1 ___
☐ Cross listed Unit 2 ___

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.

Name, Signature & Department

Home Dept. Mechanical Engineering

Cross-listed Dept(s). Anna Stefanopoulou

Form Number

1449

SUPPORTING STATEMENT

See attached documentation

Are any special resources or facilities required for this course? ☐ Yes ☑ No

Detail the Special requirements

ME 569: Powertrain Control

Winter 2005 (3 credits)

Instructor: Professor Stefanopoulou
(annastef@umich.edu)

Course description for official Publication:

The course covers essential aspects of electronic engine control for spark ignition (gasoline) and compression ignition (diesel) engines followed by recent control development for direct injection, camless actuation, active boosting technologies, hybrid-electric, and fuel cell power generation. Will review system identification, averaging, feedforward, feedback, multivariable (multiple SISO and MIMO), estimation, dynamic programming, and optimal control techniques.

Prerequisites:

Basic control analysis and dynamics background (ME 360 equivalent) and preceded or accompanied by Control design (ME 461 equivalent).

Supporting statement:

The course was introduced in Winter 03 so it has been taught twice.

Winter 2003 (25 students: 18 ME, 2 AERO, 5 AutoMEng) (Q1:**4.75**, Q2: **4.80**)
Winter 2004 (22 students: 17 ME, 2 EECS, 2 AutoMEng) (Q1:**4.50**, Q2: **4.79**)

It primarily addresses control of automotive internal combustion engines and includes gasoline, diesel and fuel cell powerplants. Although the emphasis is automotive, it includes examples from other transportation applications such as air, rail, truck, and marine. The new course has been popular among the M.S. students in Mechanical Engineering (ME), and the graduate control students in EECS, Aero departments. Its development has been coordinated with Professors Peng and Ulsoy (ME), Grizzle (EECS) and Sun (NAME). Further coordination with Prof. Schwank (CHE) is underway due to the recent emphasis in Fuel Cells.

The University of Michigan educates a large number of automotive engineers. Specifically, more than 1/3 of the mechanical engineering graduates work for the automotive industry. Many of these students will have to tune, calibrate, and design electronic and digital control systems for on-board vehicle applications. This is an area in which mechanical engineering students need more training. The proposed graduate course, which can also be attended by seniors, addresses this need, while at the same time, provides the mathematical background for rigorous system analysis and synthesis to students that can transform or extend technological boundaries in engine and fuel cell power.

Course Outline:

Chapter 1: Background and Motivation

Chapter 2: Control Oriented Modeling

The Basics: Ideal Gas Law, Mass Conservation, Energy Conservation
The Assumptions: space-averaging and cycle-averaging
The Fidelity: Detailed and Mean-Value Models
- Event-averaging in time- and crankangle-domain
- Regression and mapping data
- Linearization
- System Identification

Chapter 3: Classical Engine Control Functionalities

Air-to-Fuel Ratio Control
- For Fast Response: Feedforward Control with Air Charge Estimation
- For Accurate Response: Feedback Regulation with Oxygen Sensors (Linear and switching sensor)
- Cylinder-to-cylinder Maldistribution (Lifting Control technique)

Spark Timing Control
- The Easy Way: The Look-Up Table
- The Right Way: Feedback with KnockSensor
- The Detailed Way: Combustion sensing, Estimation Algorithms and Misfire Detection

Idle Speed Control
- The Tradeoff: Fuel economy and vibrations
- The Three Devils: Unmeasured Disturbance, Actuator Authority, and Bandwidth Limitation
- The Tools:
  - Coordinated Feedforward and Feedback
  - Adaptive Control Methodology
  - Spark Compensation—multiple SISO tuning and MIMO control design

Exhaust Gas Recirculation
- External EGR Control
  - Estimation for Gasoline and Diesel (high-speed and heavy-duty)
- Internal EGR Control
  - Control of Variable Camshaft Timing and Variable Valve Timing
  - Air and Burned Gas Charge Estimation

Chapter 4: Advanced Technology Engines

Camless Engines
- Difficulties in Idle speed control, Air and Burned Gas Charge Estimation
- Actuator Control

Turbocharged Diesel Engines
- Coordinated control of VGT and EGR for low Smoke and NOx emission
- Optimal Control of Electrically Assisted Turbocharging

Gasoline Direct Injection Engines
- Lean NOx Traps, Switching Modes, Idle Speed and AFR interactions, EGR Control

Homogeneous Charge Compression Ignition Engines
- Control and Constrains in Breathing for Controlled Autoignition

Chapter 5: Fuel Cell Power (concentration in PEM-FC Systems)

Background and Principles
Air flow, Heat, Humidity and Power management
Reactant (Air and Hydrogen) Flow Control
MIMO Control issues of Hydrogen reforming (CPOX, POX, WGSR)

ME 599: Powertrain Control

Winter 2005 (3 credits), TTH 4:00-5:30 2166 Dow

Instructor: Professor Stefanopoulou
Lay Auto Lab, G034
http://www-personal.engin.umich.edu/~annastef
annastef@umich.edu

Course statement: The course covers essential aspects of electronic engine control for spark ignition (gasoline) and compression ignition (diesel) engines followed by recent control development for direct injection, camless actuation, active boosting technologies, hybrid-electric, and fuel cell power generation. Will review system identification, averaging, feedforward, feedback, multivariable (multiple SISO and MIMO), estimation, dynamic programming, and optimal control techniques.

We will combine fundamental concepts in Matlab/Simulink simulation environment.

Open to graduate or senior students in Mechanical, Electrical, Chemical, Aerospace, and Marine Engineering with basic control engineering and dynamics background (ME 360 and ME461 equivalent). Permission from the instructor is required for senior undergraduate students.

Home Page: `http://my.ummu.umich.edu` or https://coursetools.ummu.umich.edu/2005/winter/mecheng/599/004.nsf
Will contain links to basic course information and lecture summary.

Email list: An email list is created **w5-mecheng-599-004@umich.edu**. If you register late, please ask to be added to this list by e-mailing your instructor.

Text: *Required:*
"Introduction to Modeling and Control of Internal Combustion Engine Systems" by L. Guzzella and C.H. Onder, Springer-Verlag Berlin Heidelberg 2004, ISBN 3-450-22274

Lecture notes and handouts on selected material will be distributed in class.

Optional (reserved in the Media Union):
1. Internal Combustion Engine Fundamentals, Heywood, McGraw-Hill, 1988
2. Fuel Cell Systems Explained, Larminie, and Dirks, Wiley
3. Automotive Control Systems, U. Kiencke, and L. Nielsen, SAE and Springer-Verlag,
4. G. F. Franklin, J. D. Powell, A. Emami-Naeini, "Feedback Control of Dynamic Systems," Prentice Hall, 2002.

Homework: Approximately 10 assignments. The lowest homework score will be dropped. You may discuss the homework assignments with each other and with the instructor, but you **must write your own solutions** to the homework which reflect your own understanding of the material. Homework solutions will be posted on the WWW and in the engineering library on Fridays. Homework has to be turned in the Beginning of class.

Grading: Homeworks (40%), Midterm exam (30%), Final (30%)

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Action Requested

○ New Course
◉ Modification of Existing Course
○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 9/23/2004
Effective FA 2005

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department / Div # / Course Number:	Home Department: Mechanical Engineering / Course Number: 482
Cross Listed Course Information:	Cross Listed Course Information: Manufacturing 492
Course Title:	Course Title: Machining Processes
TITLE ABBREVIATION — Time Sched Max = 19 Spaces:	Mach Processes
TITLE ABBREVIATION — Transcript Max = 20 Spaces:	Mach Processes
Course Description: Mechanics of 2-D and basic 3-D cutting. Industrially-applicable, mechanistic force models for practical processes including turning, facing, boring, face milling, end milling, and drilling. Surface generation and wear-based economic models. Motivation for and methods of applying developed models in simultaneous engineering. Three hours of lecture and one two-hour laboratory.	Course Description for Official Publication (Max = 50 words): Introduction to machining operations. Cutting tools and tool wear mechanisms. Cutting forces and mechanics of machining. Machining process simulation. Surface generation. Termperatures of the tool and workpiece. Machining dynamics. Non-traditional machining. Two hours lecture and one laboratory session.
PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k	**PROGRAM OUTCOMES:** ☒a ☒b ☐c ☐d ☒e ☐f ☐g ☐h ☒i ☐j ☒k
Degree Requirements: ○ Degree Requirement ○ Tech Elective ○ Core Course ○ Other ○ Free Elective	Degree Requirements: ○ Degree Requirement ○ Tech Elective ○ Core Course ○ Other ○ Free Elective
Prerequisites: Senior Standing ○ Enforced ○ Advised	Prerequisites: ME382 ○ Enforced ◉ Advised
Credit Restrictions:	Credit Restrictions:
Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☒ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/addt'l Work	Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☒ All Credit types ☐ Rckhm Grad w/addt'l Work
Credit Hours Min / Max: — / — ; Contact Hrs/Wk: 4 ; Number of Wks: 14	Credit Hours Min / Max: — / — ; Contact Hrs/Wk: 3 ; Number of Wks: 14
C. Repeatability (Indl Research, Dir. Study, Dissertation): Is this course repeatable? ○ Yes ◉ No; Maximum Hours? ; Maximum Times? ; Can it be repeated in the same term? ○ Yes ○ No	Printing Information (Optional): ☒ Print the course in the Bulletin ☐ Print the course in the Time Schedule
Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other; Graded Section: ◉ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other; Grading: ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y; Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension	Terms & Freq. of Offering: ☐ I ■ II ☐ IIa ☐ IIb ☐ III; ■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years; Half term ☐ 1st ☐ 2nd
	Cognizant Faculty Member: A. Shih; Title: Assoc. Professor
	Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval

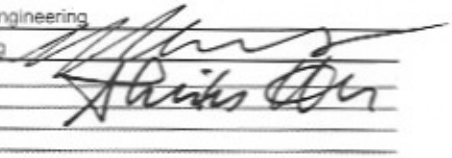
☐ Curriculum Comm. _____
☐ Faculty _____
☐ Rackham _____
☐ Cross listed Unit 1 _____
☐ Cross listed Unit 2 _____

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.

Name, Signature & Department

Home Dept. Mechanical Engineering

Cross-listed Dept(s). Manufacturing



Form Number

1447

SUPPORTING STATEMENT

Reducing class to 3 from 4 hours but retaining the lab. See changes in course syllabus and attached memo.

Are any special resources or facilities required for this course? ☒ Yes ☐ No

Detail the Special requirements

1100 Dow, the lab area for Wu Manufacturing Research Center and ERC for Reconfigurable Manufacturing Systems, will be used for ME482 lab. Sufficient lab space is available in 1100 Dow. Major machines to be operated by students are: 1. Shipley computer numerical control (CNC) lathe, 2. Fadal Machining Center, 3. Mori-Seiki CNC drilling machine, 4. Brother wire electrical discharge machine, and 5. Chevalier CNC grinding machine

Memo

Date: September 22, 2004
To: Undergraduate Committee, Mechanical Engineering
From: Albert Shih
Subject: Reduce ME482 from 4 to 3 credit hour course

The manufacturing faculty approved in Nov 2003 to reduce the ME482, instructed by Prof. Albert Shih, from a 4 credit hour (3 hour lecture and 3 hour lab) to a 3 credit hour (2 hour lecture and 3 hour lab) course. The lab is important to keep since it is the remaining course that undergraduate students have the opportunity to learn and practice the modern CNC machine tools and advanced machining technologies.

In the past years, most of the Mechanical Engineering undergraduate manufacturing courses have reduced from 4 to 3 credit hours. It is easier for students to fit a 3 credit hour ME482 in their technical elective course selection plan. ME482 is co-list as MFG482 of Program in Manufacturing (PIM). It is also easier for PIM students to match a 3 credit hour class in their study plan.

To reduce an hour of lecture for the term, several changes have been made in the course syllabus to reduce the course load.

- Machine tool subsystems related lectures are eliminated. This topic will be covered in a new ME599 Precision Engineering and Nano-Manufacturing.
- Project 1 on the team report of key machine subsystems, including base, slide, spindle, control, tool- and work-holding, fluid-delivery system, is deleted.
- Reduce the lecture in cutting tool (Chap 4), tool life (Chap 9), and machining dynamics (Chap 11) of the textbook by Stephenson and Agapiou.

The lab with student access to use the machine tool and visits to local manufacturing plants will be retained.

Attached are the revised syllabus and course schedule for ME482 in Winter 2005. The changes from the syllabus in Winter 2004 are marked for reference.

STEP II: Mechanical Engineering Program

COURSE #: ME 482	**COURSE TITLE: Machining Processes**
TERMS OFFERED: Winter.	**PREREQUISITES:** ME 382: Mechanical Behavior of Materials.
TEXTBOOKS/REQUIRED MATERIAL: Metal Cutting Theory and Practice, D. A. Stephenson and J.S. Agapiou, Dekker, 1997.	**COGNIZANT FACULTY:** **DATE OF PREPARATION:**
COURSE LEADER(S): Albert Shih	**SCIENCE/DESIGN:**
CATALOG DESCRIPTION: Introduction to machining operations. Cutting tools and tool wear mechanisms. Cutting forces and mechanics of machining. Machining process simulation. Surface generation. Temperatures of the tool and workpiece. Machining dynamics. Non-traditional machining. Two hours lecture and one laboratory session.	**COURSE TOPICS:** 1. Machining operations 2. Cutting tools – materials, coatings, and tool geometry 3. Cutting mechanics – chip formation, forces, and energy 4. Process simulation – finite element based modeling 5. Cutting temperatures – thermal modeling and measurements 6. Tool life 7. Machining dynamics 8. Non-traditional machining 9. Frontiers research topics in machining .

COURSE OBJECTIVES*	(numbers shown in brackets are links to department educational outcomes) 1. To teach the modeling technique for manufacturing processes using finite element based method [1, 5, 9]. 2. To teach implementation of design of experiments and interpretation of data for model building [1, 2, 11, 13]. 3. To teach the mechanics and thermal issues associated with chip formation [1, 5, 13]. 4. To teach the effects of tool geometry on machining force components, surface finish, and tool wear [1, 5]. 5. To teach the effects of machining dynamics and surface finish [1, 5, 13].
	(numbers shown in brackets are links to course objectives) 1. Understand the basic techniques of mechanistic modeling of manufacturing processes [1, 2]. 2. Understand the mechanical aspects of orthogonal cutting mechanics [3].

COURSE OUTCOMES*	3. Understand the thermal aspects of orthogonal cutting mechanics [3]. 4. Ability to extend, through mechanistic modeling techniques, the orthogonal-mode concepts to oblique cutting [3]. 5. Ability to extend, through mechanistic modeling techniques, the orthogonal and oblique-cutting concepts practical three-dimensional processes [3, 4, 5]. 6. Model, in an industrially useful manner, forces for practical three-dimensional machining processes [3, 4, 5]. 7. Model the deterministic components of surface generation for practical three-dimensional machining processes [4, 5]. 8. Calibrate empirical force models by designing an experiment, conducting the experiment, and identifying model parameters [1, 2]. 9. Understand the practical aspects of tool wear and tool life, and their influence on economics [3].
ASSESSMENT TOOLS	1. Regular homework problems. 2. Exam and projects. 3. Laboratory and trip reports.

*The ABET99 Group suggests up to 6 objectives and 1-3 outcomes per objective.

NEW

ME 482 Machining Processes (W05, 3 credit hours)

Instructor: Albert J. Shih, 1029 HH Dow, phone: 734-647-1766, e-mail: shiha@umich.edu

Class time: Lecture: Tuesday and Thursday 12:30 – 1:30 PM, Lab: Tuesday, 1:30 AM – 3:30 PM at 1100 Dow.

Prerequisite: ME332

Textbook:
D.A. Stephenson and J.S. Agapiou, Metal Cutting Theory and Practice, 1997, Dekker.

Course Content:
- Machining operations
- Cutting tools – materials, coatings, and tool geometry
- Cutting mechanics – chip formation, forces, and energy
- Process simulation – finite element based modeling
- Cutting temperatures – thermal modeling and measurements
- Tool life
- Machining dynamics
- Non-traditional machining
- Frontiers research topics in machining

Projects:
Two projects and presentations are the main-thrust of this course.

Project 1. (Individual project) Modeling using the Thirdwave AdvantEdge™ finite element based simulation software.

Project 2. (Term project) In-depth studying and research of a frontier machining process. It is good that the project matches your research needs and/or personal interests. The report needs to include both the experimental and analytical analysis part. Experiments using the CNC machines in the lab or at sponsor site are required. Projects will presented and a report has to be submitted by the end of the term.

Each project report needs to submit twice. I will make remarks/comments on the first draft (60% of the total project score). The student needs to make changes and submit the revised report (40% of the total project score).

Homework and Exams:
One mid-term exam near the end of the semester. No final exam.

Grading:

Project 1	20%
Project 2	30%
Mid-term exam	30%
Homework and attendance	20%

Plant visits:
Three plant visits will be arranged during the lab time. The visit including to a large-scale manufacturing facility (GM Willowrun Powertrain Plant), a job shop (Protomatic at Dexter, MI, www.protomatic.com), and a machine tool builder (Ann Arbor Machine at Chelsea, MI).

Class schedule (W05):

	Lecture	Lab	Due
Jan. 6	Introduction (Chap. 1), Overview of the course and the lab		
Jan. 11	Metal cutting operations (Chap. 2)	Demo of Lathe, Drill, EDM, and grinding machines	
Jan. 13	Metal cutting operations (Chap. 2)		
Jan. 18	**Visit to Ann Arbor Machine**	**Visit to Ann Arbor Machine**	
Jan. 20	Tool materials (Chap. 3)		Trip report
Jan. 25	Tool materials (Chap. 3)	Machine dynamics test demo	
Jan. 27	Cutting tools (Chap. 4)		HW #1
Feb. 1	**Visit to Protomatic**	**Visit to Protomatic**	
Feb. 3	Cutting tools (Chap. 4)		
Feb. 8	Chip Formation (Chap. 5)	Demo of tool force measurement	
Feb. 10	Cutting mechanics (Chap. 6)		
Feb. 15	*Thirdwave AdvantEdge training at*	*Media union training room*	HW #2
Feb. 17	*Thirdwave AdvantEdge practice*		
Feb. 22	Cutting mechanics (Chap. 6)	*Thirdwave AdvantEdge practice*	
Feb. 24	Discussion on term project		Project #1 report due
Mar. 1	No class (winter break)	No lab (spring break)	
Mar. 3	No class (winter break)		
Mar. 8	Tool life (Chap. 9)	CNC Lathe Lab	
Mar. 10	Tool life (Chap. 9)		HW#3
Mar. 15	Surface finish (Chap. 10)	Grinding Lab	
Mar. 17	Machining Dynamics (Chap. 11)		
Mar. 22	Machining Dynamics (Chap. 11)	Micro/meso scale machining Lab	
Mar. 29	Micro- and nano-scale machining		
Mar. 31	Exam (close book, four single-side	pages of note)	
Mar. 30	Non-traditional machining		
Apr. 5	Semiconductor manufacturing	EDM Machining Lab	
Apr. 7	Emerging area in machining		
Apr. 12	*Student presentation (term project)*		
Apr. 14	*Student presentation (term project)*	No Lab	
Apr. 19	*Student presentation (term project)*		Project #2 report due

*: To be held at Media Union training room

ME 482 Machining Processes (W04, 4 credit hours)

Instructor: Albert J. Shih, 1029 HH Dow, phone: 734-647-1766, e-mail: shiha@umich.edu

Class time: Lecture: Tuesday and Thursday 9 – 10:30 AM at 1010 Dow, Lab: Tuesday, 10:30 AM – 12:30 PM at 1100 Dow.

Prerequisite: ME350 or equivalent.

Textbook:
D.A. Stephenson and J.S. Agapiou, Metal Cutting Theory and Practice, 1997, Dekker.

Course Content:
- Machining operations ~~and machine tools~~
- Cutting tools – Materials, coatings, and tool geometry
- Cutting mechanics – chip formation, forces, and energy
- Process simulation – finite element ~~and mechanistics~~ based modeling
- Cutting temperatures – thermal modeling and measurements
- Tool life
- Machining dynamics
- Non-traditional machining
- Frontiers research topics in machining

Projects:
Three team-based projects and presentations are the main-thrust of this course.

~~Project 1. Machine Subsystems. Student teams to study the state-of-the-art of:~~
- ~~Base/structure (Schoeff, Koester, Marttila)~~
- ~~Tool- and work-holding (Adelman, He, Spoor, Ding)~~
- ~~Slides/motors (Fitzpatrick, Al-Awar, Constantine)~~
- ~~Spindles (Anderson, Oleniczak, Palma)~~
- ~~Drives/control (Miller, Luo, Kao)~~
- ~~MEMS and micro-machines (Zhu, Tao, Jia)~~
- ~~Coolant delivery, filtration, and temperature control (Lehv, Raymond, Peterson)~~

Project 2. Modeling using the Thirdwave AdvantEdge™ finite element based simulation software.

Project 3. Term project: In-depth studying and research of a frontier machining processes. It is good that the project matches your research needs and/or personal interests.

Each report needs to submit twice. I will make remarks/comments on the first draft (60% of the total project score). The student needs to make changes and submit the revised report (40% of the total project score).

Homework and Exams:
One mid-term exam near the end of the semester. No final exam.

Grading:

~~Project 1~~	~~15%~~
Project 2	20%
Project 3	25%

Mid-term exam	25%
Homework and attendance	15%

Plant visits:
Several plant visits will be arranged during the lab time. The visit including to the larger manufacturing facility (GM Romulus Transmission Plant), a job shop (Ann Arbor Machines shop at Jackson Rd., Ann Arbor), and a machine tool manufacturer (Ann Arbor Machine at Chelsea, MI).

Class schedule:

	Lecture	Lab	Due
Jan. 6	Introduction (Chap. 1), Overview of the course and the lab	No lab	
Jan. 8	No class, Dr. Shih attend NSF Conf		
Jan. 13	Machine components (Chap. 3)	Demo of Lathe, Drill, EDM, and grinding machines	
Jan. 15	Machine components (Chap. 3)		
Jan. 20	**Visit to Ann Arbor Machine**	**Visit to Ann Arbor Machine**	
Jan. 22	Metal cutting operations (Chap. 2)		Trip report,
Jan. 27	**Visit to Ann Arbor Machine Production Division**	**Visit to Ann Arbor Machine Production Division**	
Jan. 29	Cutting tools (Chap. 4)		Project #1 due
Feb. 3	*Project #1 class presentation at*	*Media union training room*	
Feb. 5	John Agapiou, guest lecturer on Chap. 2		
Feb. 10	*Thirdwave AdvantEdge training at*	*Media union training room*	
Feb. 12	Tool materials (Chap. 3)		
Feb. 17	*Thirdwave AdvantEdge practice at*	Machine dynamics test demo	
Feb. 19	Tool materials (Chap. 3) and Chip Formation (Chap. 5)		
Feb. 24	No class (spring break)	No lab (spring break)	
Feb. 26	No class (spring break)		
Mar. 2	Chip Formation (Chap. 5)	*Thirdwave AdvantEdge practice*	
Mar. 4	Cutting mechanics (Chap. 6)		
Mar. 9	Discussion on term project	*Thirdwave AdvantEdge practice*	HW#2
Mar. 11	Tool life (Chap. 9)		
Mar. 16	Tool life (Chap. 9)	*Thirdwave AdvantEdge practice*	
Mar. 18	Surface finish (Chap. 10)		
Mar. 23	Machining Dynamics [David Dilly] (Chap. 11)	Chevalier grinding machine	
Mar. 25	Machining Dynamics (Chap. 11)		
Mar. 30	Non-traditional machining	Micro/meso scale machine	
Apr. 1	Emerging area in machining (I)		
Apr. 6	Exam (close book, four single-side	pages of note)	
Apr. 8	Emerging area in machining (II)		
Apr. 13	*Student presentation (term project)*	No lab	
Apr. 15	*Student presentation (term project)*		
Apr. 20	*Student presentation (term project)*		

*: To be held at Media Union training room