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| MAE 517 Advanced Precision Manufacturing for Products, Systems and Processes  Summer 10 Week Session |

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|  | This is a graduate level course designed for graduate students and undergraduate seniors. This course examines precision issues for products, manufacturing machines, processes, and instruments. Modern manufacturing technologies are distinct in their multifarious nature in product sizes, materials, energy forms, theories, and information types; however, the key to their success relies on the management of precision. This course discusses issues critical to both existing precision manufacturing and future sub-micron/nano technology. Important topics include fundamental mechanical accuracies; manufacturing systems and processes; geometric dimensioning and tolerancing; process planning, tolerance charts, and statistical process control; principles of accuracy, repeatability, and resolution; error assessment and calibration; error budget; reversal principles; joint design and stiffness consideration; precision sensing and control; precision laser material processing. 3 Credit Hours. | |  |
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| Instructor  Prerequisite |  | Dr. Jay F. Tu, Professor Dept. of Mechanical & Aerospace Engineering North Carolina State University  911 Oval Drive – 4164 EB III Campus Box 7910 Raleigh, NC 27695-7910  Phone: (919) 515-5670 Fax: (919) 515-7968 E-mail: [jftu@ncsu.edu](mailto:jftu@ncsu.edu)  Undergraduate courses in manufacturing (MAE496) or engineering design (MAE415) , equivalent, or consent of instructor. Send an email to the instructor if you need approval to sign up for the course. |
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| Course Objectives |  | The goals of this course are to provide students in-depth knowledge related to precision manufacturing by focusing on the precision aspects of products, machines, processes, and process management.  This focus on precision also provides a coherent treatment to unify products, machines, processes, and process management as one close-knit field.  As a result, students, after completing this course, will have a systematic view of modern manufacturing and the skills to address the precision related problems for advancing productivity and quality. |
| Course Structure |  | The course will be taught via 3-hour lectures per week. Students could meet with the instructure for out-of-class consultation. |
| Student Learning Outcomes  Textbooks, Course Notes, and References |  | * **By the end of the course, the students will be able to:** * Demonstrate a skill to apply basic principles related to fundamental mechanical accuracy. * Interpret critical errors in precision of products, machines, and processes * Interpret geometric dimensioning and tolerancing in mechanical drawings * Identify key components which constitute a precision machine tool * Conduct error budget analysis with correct mathematical treatments * Analyze data to maintain product quality * Calibrate machines with correct precision principles * Identify technologies critical to next-generation precision designs based on literature reviews and actual test data. * Be able to apply laser material processing for manufacturing * have the ability to read journal papers related to precision manufacturing * Be able to relate the course materials to daily experience of living, in particular those related to precision performance, such as vehicle alignment, wood work, etc.   No textbook assigned. Course notes will be provided in computer files for downloads.  Students can acquired, but not mandatory, the following references.  P.K. Wright, 2001*, 21st Century Manufacturing*, Prentice Hall, ISBN 0-13-095601-5  A.H. Slocum, 1992, *Precision Machine Design*, Society of Manufacturing Engineering, call SME at  1-800-733-4763, referring to book code: 2597 or email them at service@sme.org.  W.R. Moore, 1989, Foundations of Mechanical Accuracy, The Moore Special Tool Company, Library of Congress Catalog Card Number: 73-127307 |
| Course Requirements and Grading |  | Homework assignments: 20%  Submit homework assignments via moodle  Make sure that the cover page contains the course number, instructor’s name, number of the assignment, the date the video is viewed, and the corresponding due date.  No late homework is accepted.  Examinations: One midterm exams (25%), one term report (25%) and a Final Exam (30%.)  The letter grade will be assigned based on the class average and standard deviation. In general,  A: Students score higher than the class average plus 0.75 of the class standard deviation  A-: Students score higher than the class average plus 0.5 of the class standard deviation  B+: Students score higher than the class average plus 0.2 of the class standard deviation  B: Students score higher than the class average  B-: Student score higher than the class average minus 0.5 of the class standard deviation  C: Student score higher than the average minus 0.5 of the class standard deviation  D: Student score higher than the average minus 1 of the class standard deviation  F: Student score lower than the class average minus 1 of the class standard deviation. |
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| Computer and Internet Requirements |  | NCSU has recommended minimum specifications for computers used for classes. Depending on your computer needs, we recommend your computer meet or exceed the following **minimum** specifications below.  PCs must have an Intel-compatible 800 MHz processor, 256MB RAM, 8GB hard drive with 1GB free space available, 256 Color Display, CD-ROM drive, 800x600 (min.) video adapter, sound card, and speakers. The operating system should be Windows 2000 or XP. RealOne Player Basic (available free online) and high speed Internet connection such as cable, DSL, T1 or LAN will be required for EOL courses.  Mac users must have a G3 processor with firewire and USB factory built-in, 256MB RAM, 10GB with 1GB free space available, 256 Color Display, CD-ROM drive, 800x600 (min) video adapter, sound card, and speakers. The operating system must be Mac OS X "Panther" 10.3 (minimum) along with the above RealOne and Internet specifications above.  For more detailed information on computer specifications and recommendations, please refer to our website at: <http://engineeringonline.ncsu.edu/currentstudents/computeraccess.htm>  Software Requirement: Access to standard engineering software (MATLAB, Excel, etc.)  MATLAB is accessible through the Virtual Computing Lab. PROJECTS: no. |
| Statement for students with disabilities  N.C. State University Polices, Regulations, and Rules (PRR) |  | "Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Services Office at Suite 2221, Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG 02.20.01)."  "Students are responsible for reviewing the PRRs which pertain to their course rights and responsibilities. These include: http://policies.ncsu.edu/policy/pol-04-25-05 (Equal Opportunity and Non-Discrimination Policy Statement), http://oied.ncsu.edu/oied/policies.php (Office for Institutional Equity and Diversity), http://policies.ncsu.edu/policy/pol-11- 35-01 (Code of Student Conduct), and http://policies.ncsu.edu/regulation/reg-02-50-03 (Grades and Grade Point Average)." |
| Attendance Policy |  | Students are required to sign in for each lecture. A penalty of 1 percent of the homework grade will be deducted for every unexcused absence. Excused absences of any kind will be the prerogative of the instructor. When excuses are accepted, students will be allowed for submitting excuses and for scheduling and completing makeup work. Refer to the University’s Attendance Regulation at http://policies.ncsu.edu/regulation/reg-02-20-03 for further information, including the University’s definition of excused absences. |
| Tentative  Outlines |  | 1 Needs for Precision  2 Fundamentals of Mechanical Accuracy  3 Manufacturing Processes and Machines  4 Process Capability and Statistical Process Control  5 Geometric Dimensioning and Tolerancing  6 Geometric Dimensioning and Tolerancing;  7 Feature Measurement and Inspection  8 Computer-Aided Tolerancing  9 Computer-Aided Tolerancing  10 Assessment of Errors - Homogeneous Transformation Matrix  11 Assessment of Errors - Error Budget  12 Assessment of Errors of Precision Machines - Reversal Principles  13 Assessment of Errors of Precision Machines - Calibration Principles  14 Mapping Geometric and Thermal Errors in Machine Tools  15 Mapping Geometric and Thermal Errors in Machine Tools  16 Machine Tool Structural Materials  17 Force Flow Analysis and Structure Design  18 Joint and Fixture Design  19 Kinematic Coupling Design  20 Machine Tool Spindle and Tool Holder Design  21 Measurement (grounding and shielding, amplification, and D/A conversion) and Control Basics  22 Non-Optical and Optical Sensors  23 Non-Optical and Optical Sensors  24 Non-Optical and Optical Sensors  25 Introduction to laser technology  26 Precision laser material processing  27 Precision laser material processing  28 Case Study: Gaging, inspection, and modeling of round features  29 Modern gadget manufacturing  Pre-recorded Lectures  Viewing Schedule:  1.  All lecture videos are available from the beginning of the semester.  2.  View 2 to 3 lectures per week and finish all lectures which covered in the tests before taking the tests.  Week #1: May 14-16 Week #2: May. 19-23 Week #3: May 26-30 Week #4: June 2-6 Week #5: June 9-13  Week #6: June 17-18, Mid Term Exam,  Chapters 1-6 (course notes). Check Moodle for the exam link.  Week #7: June 23 - June 27 Week #8: June 3—July 3  Week #9: July 7-11 Week #10: July 14-18 Week #11: July 21-25 (Last Week of the Semester)  Final Exam:  any day from July 28-29. Covers all the materials after the mid-term test (After Chapter 6).  Final report topic: Write a 10-page report on the precision technologies related to IC manufacturing to get to under 5 nanometer feature sizes. No references from website sites, only from at least 5 journal papers. Reference lists not included in the 10-page requirement.  Grades to be submitted by July 31. Check Moodle for exam and HW and report submission links.  All homework will be submitted via moodle. All homework related to Chapters 1-6 have the same deadline before midterm exam, while the rest of assignments have the same deadline before the final. |