MAE 517: Advanced Precision Manufacturing for Products, Systems and Processes

In Workflow
1. 14MAE GR Director of Curriculum (paul_ro@ncsu.edu)
2. COE CC Coordinator GR (rfillin@ncsu.edu)
3. COE CC Chair GR (john_classen@ncsu.edu)
4. COE Final Review GR (rfillin@ncsu.edu)
5. COE Dean GR (reeves@csc.ncsu.edu)
6. jftu (jftu@ncsu.edu)
7. jftu (jftu@ncsu.edu)
8. ABGS Coordinator (mlnosbis@ncsu.edu)
9. ABGS Meeting (mlnosbis@ncsu.edu)
10. ABGS Chair (mlnosbis@ncsu.edu)
11. Grad Final Review (mlnosbis@ncsu.edu)
12. PeopleSoft (none)

Approval Path
1. Mon, 23 Jan 2017 14:39:50 GMT
   Paul Ro (paul_ro): Approved for 14MAE GR Director of Curriculum
   Robyn Fillinger (rfillin): Approved for COE CC Coordinator GR
   John Classen (john_classen): Approved for COE CC Chair GR
4. Fri, 27 Jan 2017 14:14:56 GMT
   Robyn Fillinger (rfillin): Approved for COE Final Review GR
5. Sat, 28 Jan 2017 20:10:01 GMT
   Douglas Reeves (reeves): Approved for COE Dean GR
   Juei Tu (jftu): Approved for jftu
   Juei Tu (jftu): Approved for jftu
8. Wed, 05 Apr 2017 14:57:28 GMT
   Melissa Nosbisch (mlnosbis): Approved for ABGS Coordinator
9. Tue, 18 Apr 2017 14:53:49 GMT
   Melissa Nosbisch (mlnosbis): Approved for ABGS Meeting

New Course Proposal
Date Submitted: Mon, 23 Jan 2017 13:21:26 GMT

Viewing: MAE 517 : Advanced Precision Manufacturing for Products, Systems and Processes
Changes proposed by: jftu

Change Type
Major

Course Prefix
MAE (Mechanical & Aerospace Engr)

Course Number
Dual-Level Course
No

Cross-listed Course
No

Title
Advanced Precision Manufacturing for Products, Systems and Processes

Abbreviated Title
Precision Manufacturing System

College
College of Engineering

Academic Org Code
Mechanical & Aerospace Engr (14MAE)

CIP Discipline Specialty Number
14.1901

CIP Discipline Specialty Title
Mechanical Engineering.

Term Offering
Fall Only

Year Offering
Offered Every Year

Effective Date
Fall 2017

Previously taught as Special Topics?
Yes

Number of Offerings within the past 5 years
4

<table>
<thead>
<tr>
<th>Course Prefix/Number</th>
<th>Semester/Term Offered</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 589-004, 589-601</td>
<td>Fall, 2013</td>
<td>40</td>
</tr>
<tr>
<td>MAE 589-004, 589-602</td>
<td>Fall, 2014</td>
<td>33</td>
</tr>
<tr>
<td>MAE 589-653, as pre-recorded lectures for EOL</td>
<td>Summer I, 2015</td>
<td>19</td>
</tr>
<tr>
<td>MAE 589-603, as pre-recorded lectures for EOL</td>
<td>Fall, 2016</td>
<td>17</td>
</tr>
</tbody>
</table>

Course Delivery
Face-to-Face (On Campus)
Distance Education (DELTA)
Hybrid (Online/Face to Face)
Online (Internet)
Grading Method
Graded/Audit

Credit Hours
3

Course Length
16 weeks

Contact Hours
(Per Week)

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Contact Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

Course Is Repeatable for Credit
No

Instructor Name
Juei-Feng Tu

Instructor Title
Professor

Grad Faculty Status
Full

Anticipated On-Campus Enrollment
Open when course_delivery = campus OR course_delivery = blended OR course_delivery = flip

<table>
<thead>
<tr>
<th>Enrollment Component</th>
<th>Per Semester</th>
<th>Per Section</th>
<th>Multiple Sections?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>30</td>
<td>30</td>
<td>No</td>
<td>Single section with 30 on campus students each semester</td>
</tr>
</tbody>
</table>

DELTA/Online Enrollment:
Open when course_delivery = distance OR course_delivery = online OR course_delivery = remote

<table>
<thead>
<tr>
<th>Delivery Format</th>
<th>Per Semester</th>
<th>Per Section</th>
<th>Multiple Sections?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC</td>
<td>30</td>
<td>30</td>
<td>No</td>
<td>Single section with 30 EOL students each semester</td>
</tr>
</tbody>
</table>

Course Prerequisites, Corequisites, and Restrictive Statement
Undergraduate courses in manufacturing (MAE496) or engineering design (MAE415), equivalent, or consent of instructor

Is the course required or an elective for a Curriculum?
No

Catalog Description
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.

Justification for new course:

Currently, there is a related graduate level course, MAE 545 Metrology for Precision Manufacturing, taught by Prof. Tom Dow, within Department of Mechanical and Aerospace Engineering, which emphasizes metrology and instrumentation. This proposed course was designed in coordination with Prof. Dow to keep the overlaps between these two courses minimal when it was first offered in 2013. In fact, the overlapping parts are covered in the first two lectures, which are limited to fundamental mechanical accuracy. Because Precision Manufacturing is a diverse area, students benefit from this new course to cover different aspects of precision manufacturing, related to tolerancing, gauging, and statistical process control; principles of accuracy, repeatability, and resolution; error assessment and calibration; joint design and stiffness consideration; precision sensing and control; precision laser material processing at Department of Mechanical and Aerospace Engineering and School of Engineering at NCSU. This course is also suitable as an elective for aspiring seniors who are interested in careers in manufacturing Industry. The advance of manufacturing critically depends on the management of precision and the University will be able to help advancing manufacturing technologies by offering broader coverage of precision manufacturing to students.

Does this course have a fee?

No

Consultation

Instructional Resources Statement

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

Course Objectives/Goals

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.

Student Learning Outcomes

By the end of the course, the students will be able 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.
• Apply laser material processing for manufacturing
• Read and comprehend journal papers related to precision manufacturing
• Relate the course materials to daily experience of living, in particular those related to precision performance, such as vehicle alignment, wood work, etc.

Student Evaluation Methods

<table>
<thead>
<tr>
<th>Evaluation Method</th>
<th>Weighting/Points for Each</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes</td>
<td>5</td>
<td>5 to 10 quizzes throughout the semester</td>
</tr>
<tr>
<td>Test</td>
<td>25</td>
<td>Mid-term</td>
</tr>
<tr>
<td>Final Exam</td>
<td>30</td>
<td>Final exam</td>
</tr>
<tr>
<td>Readings assignments</td>
<td>5</td>
<td>Journal papers related to precision manufacturing</td>
</tr>
<tr>
<td>Written Assignment</td>
<td>15</td>
<td>8 homework assignments</td>
</tr>
<tr>
<td>Major Paper</td>
<td>20</td>
<td>Final report on a special topic which requires students to conduct precision analysis and design.</td>
</tr>
</tbody>
</table>

Topical Outline/Course Schedule

<table>
<thead>
<tr>
<th>Topic</th>
<th>Time Devoted to Each Topic</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Syllabus and Policies; Introduction:</td>
<td>3 hours</td>
<td>Needs for Precision; Fundamentals of Mechanical Accuracy</td>
</tr>
<tr>
<td>Manufacturing Processes and Machines</td>
<td>3 hours</td>
<td>Overview of manufacturing processes, such turning, milling, and grinding, as well machine tools such as lathe, milling machine, etc. Orthogonal cutting model, theory and practical considerations.</td>
</tr>
<tr>
<td>Process Planning and Statistical Process Control</td>
<td>6 hours</td>
<td>Focus on the designs of a sequence of machining processes to reach the final dimension and statistical control charts to each machining process.</td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing</td>
<td>9 hours</td>
<td>Detailed discussion on ANSI GD&amp;T Standards, size and geometric tolerance specifications, and CAD/CAM consideration for part precision requirements</td>
</tr>
<tr>
<td>Feature Measurement and Inspection</td>
<td>3 hours</td>
<td>Functional gage design, including go/no-go gages, instruments for roundness, flatness, concentricity, etc.</td>
</tr>
<tr>
<td>Assessment of Precision Machine Tool Errors</td>
<td>6 hours</td>
<td>Homogeneous Transformation Matrix, error budget reversal principles, calibration principles, axes of rotations, mapping geometric and thermal errors in machine tools.</td>
</tr>
<tr>
<td>Force Flow Analysis and Structure Design</td>
<td>3 hours</td>
<td>Joint and Fixture Design, Kinematic Coupling Design</td>
</tr>
<tr>
<td>Machine Tool Spindle and Tool Holder Design</td>
<td>6 hours</td>
<td>Major design consideration of high speed spindles and tool holders. Vibration and spindle stiffness are discussed.</td>
</tr>
<tr>
<td>Precision laser material processing</td>
<td>6 hours</td>
<td>Discuss lasing principle, energy coupling, plasma, melting, evaporation, and precision optics for laser material processing.</td>
</tr>
<tr>
<td>Modern gadget manufacturing</td>
<td>3 hours</td>
<td>Discuss the precision requirement and miniaturization of modern gadget manufacturing.</td>
</tr>
</tbody>
</table>

Syllabus
Additional Documentation

Graduate Course Syllabus Checklist.pdf
Learning Outcomes Guidelines.pdf

Additional Comments

I did upload the syllabus the first when I submitted this form. For some reasons, it was not attached. I am doing it again.

minosbis 2/15/2017: See justification for explanation of overlapping courses.
1) The information on the syllabus must match what is listed on the CIM Form. See prerequisites and student evaluation methods for an example where they do not match.
2) Syllabus needs attention. See these items from the Graduate Syllabus Checklist (additional attachment)
   -1- office hours
   -3- learning outcomes should be measurable, do not use "understand." See attachment.
   -4- cost of textbooks
   -6- course structure
   -10- grade determination; include the grading scale so students can see what constitutes the different letter grades
   -11- late assignments
   -12- attendance policy
   -13- disabilities statement
   -14- NC States PRR statement

pjharrie 3/2/17: In addition to the concerns outlined above, the objectives read more like a continuation of the justification rather than statements about what the learning objectives for the course are.

ABGS Reviewer Comments:
- I do not see that the students will be using machines, therefore, no state of risk is needed, I have no edits for this course.

Course Reviewer Comments

ro (Fri, 20 Jan 2017 18:33:29 GMT): Jay, can you submit your course syllabus as well?
ro (Fri, 20 Jan 2017 18:50:39 GMT): Rollback: Please attach syllabus for the course and re-submit.
jftu (Wed, 15 Mar 2017 16:52:38 GMT): I have addressed every comment listed in the section of additional comments.

Key: 13473