Precision Engineering: Fundamentals, Research & Practical Applications

Course Description:

The course will involve intensive coverage of precision engineering theory, modeling, design and manufacturing practices. Emphasis is placed on understanding precision engineering fundamentals, how they were applied to prior art and how they are pertinent to current and next generation precision applications. The fundamentals are reinforced via discussion of examples which are drawn from diverse fields:

- Nanomanufacturing equipment
- Nanopositioning equipment
- Micro-photonics and fiber optics
- Automotive manufacturing
- Telescopes and satellite systems
- Machine tools (macro, meso, and micro-scale machines) and manufacturing processes

Course Objectives:

1. Describe precision engineering theory, modeling, design and manufacturing practices.
2. Examine precision engineering fundamentals, how they were applied to prior art, and how they are pertinent to current and next generation precision applications.
3. Assess examples drawn from diverse fields, including nanomanufacturing; micro-photonics and fiber optics; automotive manufacturing; micro and meso-scale equipment; telescopes and satellite systems; machine tools and manufacturing processes.
4. Investigate new concepts in precision engineering research and experimental hardware/prototypes.
5. Examine emerging technologies in nanomanufacturing.

Course Purpose:

The successful development of technologies which need micron to nanometer-level precision (e.g. Machine tools, Nano-manufacturing, MEMS, Space-based telescopes, etc..) requires knowledge of Precision Engineering principles, their application and new technology emerging from research efforts. This course provides an overview of the fundamentals of precision engineering. Several hands-on and lab sessions will also be held.

Precision Engineering

Fundamentals, Research and Practical Application

Topics Covered:

1. Introduction and history of precision engineering
2. Fundamentals: Perspective, definitions and concepts
3. Determinism: Physics, modeling and precision systems
4. Materials and precision fabrication processes
5. Errors: Sources, modeling and mitigation strategies
6. Dynamics: Overview principals, modal analysis and Tetraform example
7. Structural design: Characteristics, requirements and design rules
8. Emerging areas and/or case studies
9. Alignment: Design of kinematic couplings
10. Hands-on: Kinematic couplings
11. Flexures: Constraint-based flexure design
12. Hands-on: Flexure bearings
13. Bearings: Brief overview of rolling, sliding and fluid elements
14. Transducers: Brief overview of common actuators and sensors
15. Materials: Properties and selection
16. Recap and discussion

Textbooks:

1) ***Precision Machine Design*** *by Alexander H. Slocum*

2) ***Foundations of Ultra-Precision Mechanism Design*** *by Stuart T. Smith*