ME 730: Ultra-Precision Machining

Course Structure

Prof. Suhas S. Joshi
Prof. Deepak Marla

Department of Mechanical Engineering, Indian Institute of Technology, Bombay, Powai, MUMBAI – 400 076 (India) Phone: 91 22 2576 7527 (O) / 2576 8527 ®; ssjoshi@iitb.ac.in
Course Structure

• **Introduction:** Definition of ultra-precision machining; Taniguchi curves of evolution of accuracy in the twentieth century; definition of Nanotechnology; Positional accuracy of today’s manufacturing processes and equipment; Deviational and scattering errors in achieving nanometric resolution.

• **Atomic-bit and atomic cluster processing methods:** Nano-mechanical, nano-physical and nano-chemical and –electrochemical processes, their capabilities and advantages.

• **Mechanism of nano-mechanical processing of atomic clusters:** Processing stress, breaking stress and processing energy density; Concept of size effect in mechanical processing; thresholds of specific energy; Nano-machining, abrasive and adhesive processing, theories of nanometric processing of ductile and brittle materials, and polymers; Failure and fracture under uniform and localized loading; Atomic-bit processing and lattice defect density, theories of nano-indentation and scratching.
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• Mechanism of nano-physical and -chemical processing of atomic-bits: Scanning tunneling effect, directional photon, electron and ion beam processing, plasma surface processing, molecular beam processing; Principles of chemical and electro-chemical processing, equilibrium of chemical and electro-chemical reactions.

• Nano-processing systems (Nano-mechanical processing) - Diamond turning: Soft metal single-point diamond turning technology, the ultra-precision CNC machine, plane and spherical mirrors machining; Nano-grinding: technology and requirements, concept of critical depth of cut, size-effect in form and fine grinding, Elid grinding, Elastic emission grinding; mechano-chemical polishing of Si wafers, principles and models; Ultra-precision polishing: Principles of ultra-precision polishing of block gauges, balls and aspherical lenses.
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• Nano-processing systems (Nano-physical and –electrochemical processing): Photo beam processing: Thermal and chemical processes in photon beam ablation; Electron and ion beam processing: removal mechanism in electron and ion beam processing, abilities and limitations; scanning tunneling microscope (STM) processing; Chemically reactive milling and etching processes, Chemically reactive deposition and consolidation, electrochemical machining and deposition processes.

• Nano-measuring systems: In-situ processes, mechanical and optical measuring systems, Scanning probe and image processing systems.

• References
## Scheme of Assessment

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<tr>
<th>Component</th>
<th>Weightage</th>
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<tbody>
<tr>
<td>Project (one/two students)</td>
<td>- 20%</td>
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<tr>
<td>Quizzes</td>
<td>- 30%</td>
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<td>End semester Examination</td>
<td>– 50%</td>
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<td><strong>Total</strong></td>
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