

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (CAD/CAM) (08) MICRO AND NANO MANUFACTURING SUBJECT CODE: 2740802 SEMESTER: IV

Type of course: Post Graduate

Prerequisite: Zeal to learn the subject

Rationale: With the advancement of technology, miniaturization of equipment is increasing. Material and hence equipment behaviour at such a small scale is different. New technologies are required to manufacture at such a small scale. The course intends to introduce technologies used for manufacturing of products at micro and nano scale.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		C	Theory Marks		Practical Marks			
			ESE (E)		PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	0	2#	4	70	30	20	10	10	10	150

Content:

Sr. No	Topic	Lectures	Weightage
1	Introduction: Micro fabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining.	5	10%
2	Micro-Machining: Material removal at micro-scale: size effect, chip thickness, Micro-Structure and Grain Size Effects; Tool geometry, Tool wear, and Tool Deflections, Tool Stiffness and Deflections under Dynamic Loading, Micro Turning and Micro Milling.	5	15%
3	Etching: Characterizing etching processes in bulk micromachining; microfabrication of MEMS and semiconductor devices; basics of microfabrication, integrated circuit fabrication; crystallography and its effects, silicon as substrate and structural material, stress and strain, crystal plane effects on etching, wet etching process, reaction phenomena, anisotropic etching, isotropic etch curves, masking for anisotropic etchants, etching control, fusion bonding of silicon on an insulator, deep reactive ion etching, fabrication of a cantilever probe, manufacture, microprocessors and applications; problems with etching in bulk micromachining.	7	15%

4	<p>Lithography: Principle of the soft lithography and applications -principle of microcontact printing and applications; characterizing the surface micromachining process, isolation layer, sacrificial layer, structural material, selective etching – properties, stress, stress measurement, stiction; wafer bonding: anodic and fusion, bonding.</p> <p>Micro and nanotechnology: Applications for space micropropulsion, subsystems and devices for miniaturised spacecrafts micropropulsion: microbolomete, micro FEEP, integrated cold-gas microthruster, microturbogas, pyrotechnic actuator and microvalve etc - propulsion systems: solid propellant, ADCS.</p>	7	20%
5	<p>Carbon nanotube production and applications: Basis of nanotechnology, structure and properties of carbon nanotubes- production of carbon nanotube: chemical vapour deposition, arc discharge, laser ablation, mechanisms of growth, purification of carbon nanotube, applications: electrical transport of carbon nanotubes for FET, Computers, nanodevices for biomedical, X-ray equipment, nanomechanic actuator and artificial muscles, fuel cells, membrane electrode assembly, mechanical and electrical reinforcement of bipolar plates, hydrogen storage</p>	9	20%
6	<p>Carbon based nanostructures: Structure of carbon nanotubes, Y-shaped, double helical, bamboo, hierarchical morphology, structure of fullerenes, structure of carbon nanoballs, structure of carbon nanofibers, porous carbon, properties of carbon nanostructures, synthesis potential applications of nanostructures - composite materials - nanotechnology for fuel cell applications: nanoparticles in heterogeneous catalysis, O₂ electroreduction reaction on carbon-supported Pt catalysts, carbon nanotubes as catalyst supports</p>	9	20%

References:

1. Koc M and Ozel T, Micro-manufacturing: Design and Manufacturing of micro products, wiley.
2. Mahalik N P, Micro-manufacturing and nanotechnology, Springer.
3. Jackson M J, Micro and nano-manufacturing, Springer.
4. Ramsden J, Micro & nano technologies, Elsevier.
5. Kahrizi M, Micromachining techniques for fabrication of micro, nano structures.
6. Gabor L H, Tibbals H F, Dutta J and Moore J, Introduction to Nanoscience and Nanotechnology, CRC.
7. Ahmed W and Jackson M J, Emergin nanotechnologies for manufacturing, Elsevier.

Course Outcome:

On completion of this course students will be able to:

1. Learn various techniques used for manufacturing and inspection.
2. Analyse and apply process parameters for micro manufacturing techniques.
3. Understand and apply fundamentals of nano manufacturing.

List of Tutorials:

1. Study paramters and their effect on micro turning.
2. Study paramters and their effect on micro milling.
3. Study of etching processing and their applications.

4. Metrology and Inspection at micro-scale.
5. Study of Lithography and its applications.
6. Study and characterization of nano structure.
7. Determine suitable manufacturing process along with instrumentation required for inspection of the same.

Major Equipment:

1. Equipment for micro-machining.
2. Equipment for metrology and inspection at micro-scale.
3. Equipment for manufacturing and characterizing nano tubes.

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.