

Subject Code: 01CA0405
Subject Name: Micro and Nano Machining
M.Tech. II Year – (Sem-IV) CAD/CAM
Type of course: Program Elective

Prerequisite: NA

Rationale: -

With the advancement of technology, miniaturization of equipment is increasing. Material and hence equipment behavior 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 (Hours)			Credits	Evaluation Scheme					Total Marks
Theory	Tutorial	Practical		Theory Marks			Practical Marks		
				ESE (E)	IA	CSE	Viva (V)	Term Work (TW)	
3	---	2	4	50	30	20	25	25	150

Course outcome

Students will be able to

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

Sr. No	Topic	Lectures	Weight
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 Turing and Micro Milling.	5	15%
3	Etching: Characterizing etching processes in bulk micromachining; micro-fabrication of MEMS and semiconductor devices; basics of micro-fabrication, 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	Lithography: Principle of the soft lithography and applications; principle of micro contact printing and applications; characterizing the surface micromachining process, isolation layer, sacrificial layer, structural material, selective etching – properties, stress, stress measurement, friction; wafer bonding: anodic and fusion, bonding. Micro and nanotechnology: Applications for space micro propulsion, subsystems and devices for miniaturized spacecrafts micro propulsion: microbolomete, micro FEED, integrated cold-gas microthruster, microturbogas, pyrotechnic actuator and micro valve etc - propulsion systems: solid propellant, ADCS.	7	20%
5	Carbon nano-tube production and applications: Basis of nanotechnology, structure and properties of carbon nano tubes- production of carbon nano tube: chemical vapor deposition, arc discharge, laser ablation, mechanisms of growth, purification of carbon nano tube, applications: electrical transport of carbon nano tubes for FET, Computers, nano devices for biomedical, X-ray equipment, nano mechanic actuator and artificial muscles, fuel cells, membrane electrode assembly, mechanical and electrical reinforcement of bipolar plates, hydrogen storage	9	20%

6	Carbon based nanostructures: Structure of carbon nano-tubes, Y-shaped, double helical, bamboo, hierarchical morphology, structure of fullerenes, structure of carbon nano balls, structure of carbon nano-fibers, porous carbon, properties of carbon nanostructures, synthesis potential applications of nanostructures - composite materials - nanotechnology for fuel cell applications: nano-particles in heterogeneous catalysis, O ₂ electro reduction reaction on carbon-supported Pt catalysts, carbon nano-tubes as catalyst supports	9	20%
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Distribution of Theory Marks

R Level	U Level	A Level	N Level	E Level	C Level
10	10	20	15	25	20

Legends: **R:** Remembrance; **U:** Understanding; **A:** Application, **N:** Analyze, and **E:** Evaluate

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 Nan science and Nanotechnology, CRC.
7. Ahmed W and Jackson M J, Emerging nanotechnologies for manufacturing, Elsevier.

List of Experiments:

1. Study parameters and their effect on micro turning.
2. Study parameters 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.