Ref. No.: Ex/PG/PRD/PE/T/123C/2025

M.E. PRODUCTION ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION - 2025

Subject: Micro-Machining & Nano-Technology

Time : Three Hours | Use Separate Answer Script for each Part | Full Marks: 100

Answer At least Two Questions from each Part

PART I

Q1. a) Differentiate between micro- machining & micro- manufacturing. What is "Tool Based Micro-machining"

b) Explain the following processes in respect of micro manufacturing: i) Lithography, ii) Electro plating 6 +(7 +7)

Q2. a) Elucidate with suitable examples how 'Surface Micro-machining' is different from 'Bulk Micro- machining'.

b)Make a comparative analysis of ECG & ELID Grinding processes

c) Explain in detail how mirror surface finish can be achieved by ELID grinding. 5+7+ 8

Q3. a) State the objectives of nano- metrology. Differentiate between Industrial and Research oriented nano-metrology.

b)With suitable diagrams explain the operation of Scanning Electron Microscope.

c)Define Nano-material. What is a one dimensional Nano-material? State some industrial applications of nano-materials. 6+7+7

Q4.a) Make a comparative analysis of Sputtering & Casting deposition techniques

b)With suitable diagrams explain the following deposition processes: i) Chemical Vapour deposition and ii) Physical Vapour deposition.

c) With suitable diagram(s) explain the working principle of Atomic Force Microscopy 6+10 + 4

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PART II

1. (a) Write the comparison between EDM and Micro-EDM process.

(b) Explain different techniquesto prepare a micro-tool forthe fabrication of high aspect-ratio hole.

(c) Briefly explainthe stages involved in Micro-EDM process for formation of spark. 6+8+6

2. (a) Explain with neat sketch laser and material interaction process.

(b) A laser beam with a power intensity of $10^5\ W/mm^2$ falls on a tungsten sheet. Find out the time required for the surface to reach the melting temperature. The given thermal properties of tungsten are melting temperature = *3400°C*, thermal conductivity = $2.15\ W/cm°C$, volume specific heat = $2.71\ J/cm^3°C$. Assume that *10%* of the beam is absorbed.

(c) A laser beam with a power intensity of $10^7\ W/mm^2$ is used to drill holes in a titanium sheet of *0.5 mm* thickness. The drill diameter is *200 μm*. If $3 \times 10^4\ Joules/cm^3$ are required to vaporize the titanium, estimate the time required to drill a through hole. The efficiency may be taken to be *20%*. 7+7+6

3. (a) For cutting a *150 μm* wide slot in a *1 mm* thick aluminum sheet, an electron beam with *5 kW* power is used. Determine the speed of cutting. (Take $C_{Aluminum} = 4.0\ W/mm^3/min$).

(b) Why vacuum is needed in Micro-EBM machining process?

(c) Explain energy transfer to the work material using disc-heating model. 7+5+8

4. (a) Explain the role of EDM in micromachining.

(b)"Material removal by ablation and etching in LBM can be performed in three different ways"- Explain these three processes.

(c) During drilling of holes in a steel workpiece by EBM, an accelerating voltage of *200 kV* is used. Determine the electron range (δ). The density (ρ) of steel is about $80 \times 10^{-7}\ kg/mm^3$. 6+8+6