Non-Traditional Manufacturing and Nanotechnology
(ME – 803)

Time: 3 hours

Full Marks: 70

Use separate answer script for each half.
Answer SIX questions, taking THREE from each half.
The questions are of equal value.

FIRST HALF

1. (a) Draw a neat flow-chart diagram of Photo-Chemical Machining (PCM) process and discuss the steps followed.

   (b) State the different applications of Photo-Chemical Machining process.

2. (a) Draw neat labeled sketches of a solid state laser and a gas laser.

   (b) Name the significant properties of laser beam and enumerate the general applications of laser.

3. (a) State the cut quality characteristics and process characteristics of laser cutting.

   (b) Give a comparative list of the different laser cutting methods. Write the energy balance equation for fusion cutting (melt & blow) method.

4. (a) Draw the schematic diagram of Abrasive Jet Machining (AJM) set-up and label its various components.

   (b) Prove that the material removal rate for ductile work material in AJM process is given by $MRR_{ductile} = 0.5\dfrac{MV^2}{H}$. The notations carry their usual meanings.

5. (a) With the help of a neat labeled sketch describe the constructional features of an electron beam gun.

   (b) Enumerate the applications of EBM.

6. (a) Close tolerance between job-tool interface increased production rate in ECM operation, yet it is not desirable, justify. What is over-voltage? Prove at equilibrium condition, the feed rate is equal to the velocity of recession of the dislodged material.

(b) The chemical composition of a turbine blade made of alloy is 19% Co, 60.5% Ni and 20.5% Cr. It is being machined electrochemically with a current of 1450 amp. Find the volume rate of metal removal. Take the following parameter if necessary:

	Co	Ni	Cr
Density (gm/cm³)	8.85	8.88	7.25
Valency	2	2	6
Atomic weight	59	58.7	52

7. (a) Write the effect of conductivity of the dielectric fluid on MRR in EDM process. Deionized water gives higher MRR and better cooling in EDM process yet not used in practice - justify. Write the effect of resistance, capacitance and spark-gap on MRR in EDM operation.
    (b) Write the mechanics of MRR in USM process. Derive an expression for MRR in USM process.

8. (a) Why transducer-concentrator assembly is used in USM process? Prove that for maximum power delivery the discharge voltage in EDM would be 72% of the supply voltage..
    (b) A cylindrical hole of 10 mm diameter has to be drilled in a 5 mm thick tungsten carbide sheet in USM operation. The slurry is made of 1 part of abrasive with 1 part of water. The feed force is constant and equal to 5.5 N. The tool oscillates with amplitude of 30μ at 25 kHz. The average diameter of the abrasive grains in the slurry is 0.01 mm. The fracture strength of the tungsten carbide may be taken as 7500 MPa. Estimate the machining time.

9. (a) How the concept of Nano-technology is developed? Write the different approaches of nanotechnology. What is Nanometer and Nanoscale? Write the applications of Nano technology in manufacturing.
    (b) Derive an expression for MRR in EDM process using R-C circuit.

10. Write short notes in the followings:

    (a) Equilibrium gap in ECM operation
    (b) Application of ECM in manufacturing industry
    (c) Electrodes and power supply in EDM operation