M.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2025
ADVANCED METHODS OF MACHINING

Time: 3 Hours | Full Marks: 100

Assume any relevant data, if necessary. Symbols in the Question Paper carry their usual meanings. Figures in the margin indicate full marks.

Answer any five questions

Q1. (a) Draw a schematic diagram of Ultrasonic Machining (USM) set up and describe the working principle of USM.
(b) Discuss the influence of process parameters of USM on (i) Machining rate and (ii) Surface finish.
(c) Name any two commonly used tool materials in USM and state why these are suitable?
(d) Find out the approximate time required to through machine a square hole 5 mm × 5 mm in tungsten carbide plate of 4 mm thickness if the abrasive grits are 0.01 mm in diameter, the amplitude of vibration is 0.025 mm, the frequency being 25kHz. Take the tungsten carbide fracture hardness to be 6900 N/mm^2. The concentration of the abrasives in the slurry is defined by 1 part abrasive to 1 part water by volume. Static force F is 3.5 N. Assume, ratio of the hardness value of work material to tool material is 5. [5+3+2+10=20]

Q2. (a) Discuss the mechanism of material removal for AJM. State the limitations of AJM.
(b) Explain the effects of mixing ratio, abrasive mass flow rate and stand-off distance on MRR during AJM.
(c) Prove that $Q = \chi Z d^3 v^{3/2} \left(\frac{\rho}{12Hw}\right)^{3/4}$, where Z is the number of abrasive particles impacting per unit time, d is the mean diameter of the abrasive grains, v is the velocity of the abrasive grains, ρ is the density of the abrasive material, Hw is the hardness of the work material (the flow stress), and χ is a constant. [4+6+10=20]

Q3. (a) Describe the chemistry of ECM process and MRR by drawing a neat figure.
(b)In an electrochemical machining (ECM) process with a pure iron workpiece, a removal rate of 5cm^3/min is desired. Determine the current required. Also deduce the formula required. The gram atomic weight, valency and density of iron are 56 gm, 2, and 78 gm/cm^3 respectively.
[(5+5)=+10=20]

Q4. (a) Prove that in a steady state or equilibrium condition with a constant feed, the gap between tool and work piece in ECM process remains constant.
(b) During an ECM operation on an iron workpiece with a square-face copper tool (using brine as the electrolyte), both having a flat surface, a feed rate of 2 mm/min is used. The DC voltage used is 10 V and the total overvoltage is 1.5 V. The dimension of the tool face is 25.4 mm×25.4 mm. The boiling temperature of the electrolyte is 95°C. Find out the total force acting on the tool. Use the data:
viscosity of electrolyte =0.876×10^{-3} kg/m-sec,
density of electrolyte = 1.088 g/cm^3,
specific heat of electrolyte =0.997,
conductivity of electrolyte =0.2Ω^{-1} cm^{-1},
ambient temperature (initial temperature of electrolyte) =35°C.
Neglect the variation in electrolyte conductivity due to the temperature change. The electrolyte is fed from one side of the square-shaped tool.

Q5. (a) Explain the principle of generation of laser. Sketch and describe laser beam machining process.
(b) Discuss various process parameters of LBM process.
(c) List advantages, Limitations and applications of LBM process. [10+5+5=20]

Q6. (a) Explain the working principle of Electro Discharge Machining (EDM) with a neat sketch. Explain the function of dielectric fluid used in EDM.
(b) During an electrical discharge drilling of a 10 mm square hole in a low carbon steel plate of 5 mm thickness, brass tool and kerosene was used. The resistance and the capacitance in the R-C circuit are 50 Ohm and 10 micro-Farad respectively. The supply voltage is 200 volts and the gap is maintained at such a value that the discharge (sparking) takes place at 150 volts. Estimate the material removal rate (MRR) and time required to complete the drilling operation. [(6+4)+10=20]

Q7. Write short notes (any two) [10×2=20]
(a) Classification of non-traditional machining based on nature of energy employed
(b) Relationship between the voltage applied across the electrodes and the flow of current in ECM
(c) Principle of working of Plasma Arc Machining (PAM) process.

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