*Ref. No.* **Ex/PG/LST/T/113A/2024**

**M.Tech. in Laser Tech. Examination, 2024**

**(1st Semester)**

**SUBJECT: Laser Machining Processes**

**Time : Three hours** **Full Marks 100**

| No. of questions | | Marks |
|---|---|---|
| | Answer any FIFTY Marks from **Part-I.**<br>Use Separate Answer Script | |
| | **Part-I** | |
| **1.** | What are the different aspects to inspect the quality of laser cutting? | **4** |
| **2.** | What are the different mechanisms for laser cutting of non-metals? | **9** |
| **3.** | Compare different kerf cross sections produced by Nd:YAG Laser Cutting, Plasma –arc cutting, Abrasive water Jet cutting and Oxgen-Flame cutting with schematic diagram. | **4** |
| **4.** | Compare laser cutting, water jet cutting and sawing/router operation for cutting plastic material. | **3** |
| **5.** | What are the functions of the assist gas in laser cutting? | **5** |
| **6.** | Compare briefly EDM, Chemical Milling and Laser drilling process for generating small diameter holes (<0.025mm dia). | **6** |
| **7.** | Explain Eximer laser Drilling process very briefly with suitable figure | **7** |
| **8.** | Write short notes on<br>a) Nanomaterials;<br>b) Shape memory alloys;<br>c) Zirconia;<br>d) Silica;<br>e) Ceramic-Matrix Composites (CMC) | <br>**4**<br>**4**<br>**4**<br>**4**<br>**4** |

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## Part II

Answer any ***Two*** question

**1. a)** A 2.5 mm thick stainless steel plate is cut using a 3.0 kW laser. If the resulting kerf width is 0.75 mm; the ambient temperature is 26 °C; and 60% of the incident laser beam is absorbed by the plate, determine the cutting speed. You may assume that there are no energy losses by conduction, convection, or radiation. **10**

Average density, $\rho$ = 7830 kg/m$^3$; Specific Heat (liquid), cp = 837 J/kg.K; Specific Heat (vapor), cp = 371 J/kg.K; Latent heat of fusion, Lm = 243 kJ/kg; Melting temperature, $T_m$ = 1723 K; Vaporization temperature, $T_v$ = 3135 K; Latent heat of evaporation, Lv = 6289 kJ/kg.

**b)** Explain the material removal mechanisms in laser fusion cutting and sublimation cutting. **10**

**c)** Explain the effect of laser parameters on the laser cutting process. **5**

**2. a)** Explain the mechanisms and advantages of ultrafast laser material processing with neat sketch. **15**

**b)** Discuss the theory of evaporation flow from melt surface into air during the laser ablation. **10**

**3. a)** What is laser beam stability? **2**

**b)** An Nd:YAG laser generates pulses of intensity 40 MW/cm$^2$ for drilling 200 µm diameter holes in a aluminium plate. Estimate the drilling speed that can be achieved for this operation. Assume ambient temperature and pressure of 25°C, and $0.1\times10^6$ Pa, respectively, and that the diameter of the hole is the same as the beam diameter. **14**

Average density, $\rho$ = 2600 kg/m$^3$; Specific heat, cp = 945 J/kg.K; Latent heat of fusion, Lm = 397 kJ/kg; Melting temperature, Tm = 945 K; Vaporization temperature, Tv = 2600 K; Latent heat of evaporation, Lv = 10530 kJ/kg; Thermal conductivity, k = 95 W/m.K; Boltzmann's constant, $k_B$ = 1.38 × $10^{-23}$ J/K; Avogadro's number, $N_0$ = 6.023 × $10^{23}$ molecules; Atomic weight, Wa = 26.98 g/mol

**c)** Write short notes on the following: (a) Recast layer, (b) Laser trepanning drilling, (c) Microcracking **9**