(i) Answer all the questions. (ii) all steps are necessary to get full credit (iii) Each part of the question has to be answered in one place for evaluation.

PART A

1. Note down the different condition of friction factor along with the effects on filament for fused deposition modeling process. **[3]**

2. Why reverse polarity is used in electro discharge machining? Give an example. **[2+1]**

3. "Copper tungsten alloy cannot be used as a tool material during die sinking EDM of a small precise hole (2 mm diameter and depth 4mm)"-state the statement is true or false. Justify your answer. **[2]**

4. Draw circuit of hybrid generator used in EDM, and show time vs voltage curve. **[2+1]**

5. A semiconducting material has 3.2eV band gap energy. Which laser beam will get absorbed by this material. Show calculation.

(i) CO_2 10.6 μm (ii) Nd:YAG laser 1.06 μm (iii) Excimer laser 248 nm. **[3]**

6. Higher absorption coefficient results in high absorptivity of laser beam-True or false. Give reason. **[1]**

7. Why a thin layer of water is used on the surface for laser shock peening? **[1]**

8. How many triangles will be required for angle tolerance to be 1° to represent a cylinder of 100 mm radius by STL format. **[4]**

PART B

1. (a) Neo is manufacturing his space suit made of iron using electrochemical machining process. During operation, he maintained an equilibrium gap of 4 mm. He also measured overvoltage for this process as 4 V. He collected following data from technical handbook: resistivity of electrolyte is 50 Ω-mm, valency of iron=2, atomic weight of iron=56, Faraday's constant=96500 coulombs, density of iron=7.8 g/cc. He is trying to find out the required supply voltage when he set feed as 0.5 mm/min. Help him to calculate the supply voltage by showing all the steps. **[8]**

(b) Rancho is a student of a reputed technical institution. A demonstration was given on electrochemical machining process in a course. He was interested to understand the process in more detail, and hence visited the operator in leisure time. The operator was cutting a through hole in the same machine into a 12 mm thick aluminum plate. The hole is rectangular with a

dimension of 10mm×30mm. The time taken to perform this operation (drilling mentioned above) is 2 minutes. Operator informed him that the efficiency is known to be 90% in this case. The operator asked him to calculate the current (A) considering specific material removal rate for aluminum 3.44×10^{-2} mm^3/A-s. Estimate the current to help Rancho. **[7]**

2. (a) In a fused deposition modeling process, pressure for zone 1, zone 2 and zone 3 is given as 734 Pa, 81000 Pa, 23000 Pa. The filament diameter (d_f) used for this process is 1.5 mm. Given, E=19 MPa.

(i) Calculate the pressure drop in the liquefier.

(ii) What will be force required to push the wire into the liquefier?

(iii) Determine the maximum possible value of length from pinch rollers to entry of the liquefier (L_f) to avoid buckling. **[1+4+4=9]**

(b) Write a seven line STL file code for given triangle. Vertex points given as: P1(400,100,0), P2(400,0,300), P3(400,0,0), respectively. Now, show that facet normal data is redundant for the STL file. **[2+4=6]**

3. (a) A 1.06 µm fiber laser is utilized to perform conduction welding of suitable work piece. Welding velocity is chosen as 2 m/min. Laser focal spot diameter on the surface is given as 500 µm. Reflectivity of the laser is 0.4 for this material. Coefficient value that accounts for conduction loss is given as 0.48. Following material properties are also given: Thermal conductivity, K=52 W/mK, Density of the material, ρ=7800 Kg/m^3, Specific heat, C_p =460 J/KgK, Melting point of the material, T_m =1750K, Latent heat of fusion, L_f =275 kJ/Kg. Find out the following: (i) laser interaction time (ii) weld depth (iii) laser power required (iv) laser power density. **[1+4+5+2=12]**

(b) Explain the process of laser absorption in the following types materials: (i) organic polymers (ii) ceramic (iii) semiconductor. **[3]**

4. (a) A graduate engineer trainee working on electro discharge machine is not conversant with the process completely. He connected the machine to 60V supply instead of ideal supply 40V. Calculate the ratio of ideal to actual material removal rate. Actual refers to the material removal rate when it is connected to 60V supply. You can assume that the machine is using relaxation type circuit, and condition for maximum power delivery to the discharge circuit is satisfied. **[5]**

(b) Show plot of time and current in case of charging and discharging circuit for EDM process (relaxation circuit).

(c) In a RC type generator, the maximum charging voltage is 60 V and the charging capacitor is 100 µF. Determine spark energy. **[2+2=4]**

(d) Derive a model that can estimate surface roughness produced by electro discharge machining process. Following process parameters is necessary to consider for the modeling: voltage, current, pulse on time. Now, calculate maximum height of the surface roughness using the expression you derived by taking current as 5A, voltage 40V, pulse on time 4µs.

[4+2=6]