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MEC-E7006 Advanced Production Technologies

Questions for exam

1. Consider a laser micromachining device that includes a laser and a galvanometric scanning system designed to remove thin layers of plastic from a metallic substrate. Calculate the minimum power needed for the laser to remove a circular area of 4 mm^2 of a 0,2 mm thick plastic layer in 100 ms. Assume that the laser needs to heat the material to 350 °C for vaporization. Assume a typical specific heat for plastic material to be 1500 J/(kg °C) and the density to amount 800 kg/m^3.

2. What are those features of a part that can be produced particularly well using Additive Manufacturing technologies as compared to traditional manufacturing technologies?

3. Using a digital light processing (DLP; belongs to the group of vat photopolymerization) 3D-printer, calculate part cost for:

   a) when you are printing one part and
   b) when you are printing 300 parts (identical).

   Part dimensions are 3 cm x 3,5 cm and 5 cm in height. Layer thickness is 0,08 mm. The build bed area is 400 mm x 400 mm. The distance between parts is at a minimum of 3 mm between the parts and 10 mm to the borders of the build bed area. Assume that a projector is used for exposure and illumination time for each layer (9 s), delay after illumination to ensure hardening is 3 s and recoating time is 2 s. Assume that preparation and warm-up time for the 3D-printer to be 10 min and part removal time to be 20 min. Components need to be post cured after the print, 100 parts can be cured in one cycle using a large-scale curing device. This process takes 2 hours and results in additional 50 € for up to 100 parts at once.
   The weight of each part is 30 g and the material cost is 100 €/kg. The equipment cost is 80 000 € and it is amortized in 10 years, software and maintenance cost amount 50 000 € and are amortized in 8 years. The expected usage is 4000 h in a year.

$$t_L = \frac{A_L}{V_{ext}\ S_{line}} + t_s \qquad d = \frac{4\lambda M^2 f}{\pi D}$$

$$V = d\ h\ v_s\ \Delta t \qquad E = C_h\ \rho\ V\ \Delta T$$

$$t_B = \sum_{\text{all layers}} t_L \qquad N_n = \frac{C_{CI}}{C_{AMP} - C_{CP}}$$