ME 323
Instructor: Ramesh Singh
HW# 3

Date assigned: 05.10.2025
Date due: 12.10.2025

1. Explain the mechanism of power attenuation in powder laser DED and derive a formulation for power attenuation for coaxial powder deposition and estimate the heat partition between the substrate and the clad. What is the preferred intensity distribution for laser in powder laser DED and why? If the laser is not perpendicular to the surface but inclined at an angle, how will the power attenuation be estimated? Explain (do not solve)

2. The mass flow rate ($\dot{m}$) varies from 5 g/min to 25 g/min and the powder focusing diameter is 4 mm which is injected into the melt-pool on the substrate. The substrate melt-pool width (w) is 3.5 mm and length (l) is 9 mm. Assume that the melt-pool is a semi-circle in the leading edge and a semi-ellipse in the trailing edge. The velocity is 0.5 m/min.
    a. Find the value of catchment efficiency, η, if the laser powder cate enter and the center of the semi-circle are collocated. The overlap area between the focused powder and the melt-pool defines the catchment efficiency.
    b. Derive an expression of the deposition height (h) as a function of $\dot{m}, \eta, \rho, v$. $\rho \ and \ v$ are bulk density of the powder material and scan velocity, respectively. Plot the variation in height, and identify the limit for preferable deposition height.
    c. Derive the expression for the contact angle of the deposition in terms of w and h. Also plot the contact angle as a function of the range of $\dot{m}$, and identify the limit for preferable contact angle.

3. Describe the PBF process and the different types of PBF processes. Compare SLM vs. EBM process.
4. Write a pointwise comparison of DED and SLM process.