1- Air at a free stream temperature of \( T = 20^\circ C \) is in parallel flow over a flat plate of length \( L = 5 \) m and temperature \( T = 90^\circ C \). However, obstacles placed in the flow intensify mixing with increasing distance \( x \) from the leading edge, and the spatial variation of temperatures measured in the boundary layer is correlated by an expression of the form \( T(\,^\circ C) = 20 + 70\exp(-600xy) \), where \( x \) and \( y \) are in meters. Determine and plot the manner in which the local convection coefficient \( h \) varies with \( x \). Evaluate the average convection coefficient \( \bar{h} \) for the plate.

2- A 5-cm-diameter shaft rotates at 4500 rpm in a 15-cm-long, 8-cm-outer-diameter cast iron bearing \((k = 70 \, W/m.K)\) with a uniform clearance of 0.6 mm filled with lubricating oil \((\mu = 0.03 \, N.s/m^2 \text{ and } k = 0.14 \, W/m.K)\). The bearing is cooled externally by a liquid, and its outer surface is maintained at 40° C. Disregarding heat conduction through the shaft and assuming one-dimensional heat transfer, determine (a) the rate of transfer to the coolant, (b) the surface temperature of the shaft, and (c) the mechanical power wasted by the viscous dissipation in oil.

3- An object of irregular shape has a characteristic length of \( L = 1 \) m and is maintained at a uniform surface temperature of \( T_s = 400 \) K. When placed in atmospheric air at a temperature of \( T_\infty = 300 \) K and moving with a velocity of \( V = 100 \) m/s, the average heat flux from the surface to the air is 20,000 W/m\(^2\). If a second object of the same shape, but with a characteristic length of \( L = 5 \) m, is maintained at a surface temperature of \( T_s = 400 \) K and is placed in atmospheric air at \( T_\infty = 300 \) K, what will the value of the average convection coefficient be if the air velocity is \( V = 20 \) m/s?