Problem 1: This problem deals with the *non-isentropic* flow of an ideal gas through a diffuser. Air at 278 K, 80 kPa decelerates from 210 m/s to 60 m/s in a diffuser. Exit pressure is 90 kPa. Calculate change in stagnation pressure, change in entropy, and diffuser isentropic efficiency.

Problem 2: Air is filled inside a vacuum tank from the atmosphere. The inlet is in the form of a De-Leval nozzle with entrance, throat, and exit areas as 2 m^2, 1 m^2, and 4 m^2, respectively. Show that the air can be drawn inside the tank at a maximum rate of 241 kg/s.

Problem 3: Consider a converging-diverging nozzle with an exit-to-throat area ratio of 5 exhausting air from a chamber to the atmosphere. Find the range of back pressure to chamber pressure ratio p_b/p_c for which there is a shock in the nozzle. With a shock in the nozzle, the exit Mach number is measured to be 0.35. Determine the Mach number before the shock, the cross-sectional area where it will form (relative to the throat area), and the back pressure to chamber pressure ratio.

Problem 4: Properties of air before (upstream) of the shock are given: v= 680 m/s, p=8 kPa, T= 333 K. Determine velocity, static, and stagnation properties after the shock. What is the increase in entropy?

Problem 5: A CD nozzle with an area ratio (exit to the throat) of 3.0 exhausts air ($\gamma = 1.4$) from a large high-pressure reservoir to a region of back pressure p. Under a certain operating condition, a normal shock is observed in the nozzle at an area equal to 2.2 times the throat area. What percent of the decrease in back pressure would be necessary to rid the nozzle of the normal shock?

Problem 6: A fighter aircraft engine intake is designed to operate under isentropic conditions at M = 3 at 10,000 m altitude. Determine the Mach number for which the aircraft must accelerate to achieve isentropic flight conditions. What is the net loss in stagnation pressure at that condition?