1. Calculate the constant

\[ C_n = \int_{\sum x_i^2 < 1} \prod_{i=1}^n dx_i \]

using mathematical induction and the fact that \( C_2 = \pi \) and \( C_3 = 4\pi/3 \). Compare with the result in the textbook [in particular, calculate \( \Gamma(2) \) and \( \Gamma(5/2) \)]. (5 pt)

2. Problem 6.4 [for the case of different gases] (3 pt)

3. Problem 6.3 (a) - (c) (6 pt)

4. Consider equilibrium of a body in an external time-independent field, for example, in gravitational field. The system is no longer spatially uniform. Still equilibrium with respect to particle exchange requires that \( \mu = \text{const} \), but now the chemical potential may depend on coordinates. In a gravitational field, the energy of a particle of a mass \( m \) has just an extra term \( u(r) = mgz \). Then the chemical potential per particle has the form

\[ \mu(P,T) = \mu_0(P,T) + u(r), \]

where \( \mu_0 \) is the chemical potential in the absence of the field. Prove this relation (3 pt) and derive the equation for \( P \) as a function of coordinates for a compressible system (3 pt).

5. Problem 6.1 (4 pt)

6. Problem 6.2 (4 pt)