



# Department of Physics

Indian Institute of Technology Kharagpur  
Kharagpur-721302, West Bengal, India

Subject No. PH41023(Statistical Physics-I)

Tuesday 31<sup>st</sup> January, 2023

Assignment Due date : 1<sup>th</sup> February 2023

Total Marks: 10

## Assignment # 3

- §1. An ideal gas with adiabatic exponent  $\gamma$  undergoes a process in which its pressure  $P$  is related to its volume  $V$  by the relation  $P = P_0 - \alpha V$ , where  $P_0$  and  $\alpha$  are positive constants. The volume starts from being very close to zero and increases monotonically to  $\frac{P_0}{\alpha}$ . At what value of the volume during the process does the gas have maximum entropy?
- §2. Consider a system maintained at temperature  $T$ , with two available energy states  $E_1$  and  $E_2$  each with degeneracies  $g_1$  and  $g_2$ . If  $p_1$  and  $p_2$  are probabilities of occupancy of the two energy states, what is the entropy of the system?
- §3. Suppose that the number of microstates available to a system of  $N$  particles depends on  $N$  and the combined variable  $2UV$ , where  $U$  is the internal energy and  $V$  is the volume of the system. The system initially has volume  $2m^3$  and energy 200 J. It undergoes an isentropic expansion to volume  $4m^3$ . What is the final pressure of the system in SI units?
- §4. Assume that the energy  $E$  of a system can be given by the sum of  $n$  independent quadratic terms, so that

$$E = \sum_{i=1}^n \alpha_i x_i^2$$

where  $\alpha_i$  are constants and  $x_i$  are some variables. Assume also that each  $x_i$  could in principle take any value with equal probability. Calculate the mean energy.