भारतीय प्रौद्योगिकी संस्थान पटना

INDIAN INSTITUTE OF TECHNOLOGY PATNA

PH424 (Statistical Physics) **February 19, 2024**

QUIZ-I [F.M. 25]

Roll Number and Name:

USEFUL INSTRUCTIONS • Please write your roll number and name in the space provided above before answering the questions. • All the questions are compulsory. • Read the questions carefully and answer only what is asked (not abiding to this will attract negative credits). • Answers to all parts of a given question must be written together (otherwise, only the part appearing the first will be evaluated). • Make suitable approximations wherever applicable.

1. **[5 MARK]** What is ergodic hypothesis? Why is this crucial to statistical physics?

2. **[5 MARK]** In the case of Laplace distribution $p(x) = \frac{1}{6\alpha} exp(- \mid x \mid /3\alpha)$, obtain the characteristic function $p(\tilde{k})$. Use this to find the first two cumulants of the Laplace distribution.

3. **[15 MARK]** The Hamiltonian of a system of N localized particles of spin 1/2 in the presence of an external magnetic field H is given by: $\mathcal{H} = -\mu_0 H \sum_{i=1}^{\mathrm{N}} S_i$, where, $H > 0$; the set of spin variables, $\{S_i\}$, with $S_i = \pm 1/2$, for $i = 1, 2, \cdots, \mathrm{N}$, characterizes the microscopic state of the system. For a fixed energy E, obtain the expressions for: (a) number of accessible microstates,(b) entropy per particle, (c) internal energy per particle, (d) magnetization (defined as $m = \frac{\mu_0(N_1 - N_2)}{\mathrm{N}}$, where, N_1 and N_2 are the number of particles with spin $+1/2$ and $-1/2$, respectively), (e) Plot the variation of entropy per particle, internal energy per particle and magnetization as a function of temperature.