**PH2202 Thermal Physics**
**Fall Semester - 2023**
Indian Institute of Science Education and Research, Kolkata
Instructor: Koushik Dutta

---

Homework: 1 Submission Date: 9/1/2023

The hand written assignments must be submitted at the start of the tutorial.

1. Consider the following two expressions for two thermodynamics systems in equilibrium:
   (i) $S = A^{1/3}(NVU)^{1/3}$ (ii) $S = B^{1/3}(NU/V)^{2/3}$. Here, $A$ and $B$ are constants, and other letters have their usual meaning in thermodynamics.
   (a) One of these two expressions violates one of the important properties of thermodynamics and therefore not physically acceptable and the other one is correct in that respect. Show it.
   (b) For the correct expression, find out the equation of state for the system, *i.e.*, find out the function $f(p, V, N, T) = 0$.

2. If $z$ is defined implicitly as a function of $x$ and $y$ by $x^2 + y^2 - z^2 = 3$, find $\partial z/\partial x$ and $\partial z/\partial y$.

3. Let $z = f(x/y)$, where $f$ is an arbitrary differentiable function, show that $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = 0$.

4. Given a relationship $F(x, y, z) = 0$, where $F$ has nonzero partial derivatives with respect to its arguments, show that $(\partial x/\partial y)(\partial y/\partial z)(\partial z/\partial x) = -1$.

5. In that class we have shown that $dF = \frac{\partial F}{\partial x}dx + \frac{\partial F}{\partial y}dy$ where $F(x, y)$ is a function of two *independent* variables $x, y$. Show that this equation holds even when $x$ and $y$ are *dependent* variables.