Section B. Statistical Mechanics and Thermodynamics

1. **String Thermodynamics**

   An elastic string is found to have the following properties:

   - To stretch it to a total length x requires a force $f = \mu x - \alpha T + \beta T x$. Assume that α, β, μ are constants.
   - Its heat capacity at constant length x is proportional to temperature: $C(x) = A(x)T$.

   We can use thermodynamic identities to derive from these facts a variety of other thermal properties. More specifically:

   (a) Calculate $\frac{\partial S}{\partial x}|_T$.

   (b) Show that A has to be independent of x.

   (c) Calculate $\frac{\partial S}{\partial T}|_x$ and give the general expression for entropy $S(x, T)$ assuming $S(0, 0) = B$, where B is a constant.

   (d) Compute the heat capacity at zero tension $C_F = T\frac{\partial S}{\partial T}|_{f=0}$.