**Problem 1. Differential entropy**
Evaluate the differential entropy \( h(X) \) for the following:

a) Guassian distributions with density, \( f(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right) \).

b) The exponential density, \( f(x) = \lambda \exp(-\lambda x), x \geq 0 \).

c) The Laplace density, \( f(x) = \frac{1}{2\lambda} \exp(-\lambda|x|) \).

**Problem 2. Channel with uniform distributed noise**
Consider a additive channel whose input alphabet \( \mathcal{X} = \{0, \pm 1, \pm 2\} \) and whose output \( Y = X + Z \), where \( Z \) is distributed uniformly over the interval \([-1, 1]\). Thus, the input of the channel is a discrete random variable, where as the output is continuous. Calculate the capacity \( C = \max_{p(x)} I(X; Y) \) of this channel.

**Problem 3. Quantized random variables**
Roughly how many bits are required on the average to describe to three-digit accuracy the decay time (in years) of a radium atom if the half-life of the radium is 80 years? Note: The half-life is the median of the distribution.

**Problem 4. Shape of the typical set**
Let \( X_i \) be i.i.d. \( \sim f(x) \) where
\[
f(x) = ce^{-x^4}.
\]
Let \( h = -\int f \ln f \). Describe the shape/form or the typical set \( A_n^o = \{(x_1, x_2, ..., x_n) \in \mathbb{R}^n : f(x_1, x_2, ..., x_n) \in (2^{-n(h+t)} , 2^{-n(h-t)})\} \).