Methods of Computational Physics - 2022, Assignment No. 03

(Date: 19 August, 2022; Due Date: 26 August, 2022)

Note: Print and file only the program listings and plots. Do not print output files of the programs, unless specifically asked in the question.

Q1 Generate a sequence of $n = 10000$ random values according to the following distribution $p(x)$ using inverse transform method. Plot the distribution these values (use bin size 0.01) and also the theoretical distribution (given below) on the same set of axes.

$$p(x) = \begin{cases} 2(1-x) & \text{for } 0 \leq x \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

Q2 Generate a sequence of $n = 100000$ random values according to the gaussian distribution with mean $\mu = 10$ and standard deviation $\sigma = 2$ using Box-Muller algorithm. Plot this distribution (use bin size 0.01) as well as the theoretical distribution on the same set of axes.

Q3 Generate a sequence of $n = 110000$ random values according to the following distribution $p(x)$ using Metroplois Monte Carlo method. Use the initial value $x_0 = 0.0$, and increment $\Delta x \in [-\delta, \delta]$ where $\delta = 0.3$.

$$p(x) = \begin{cases} Ae^{-x} & \text{for } 0 \leq x \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

In the above $A > 0$ is the normalization constant.

(a) Discard the first $m = 10000$ values generated (equilibration) and plot the distribution for the rest $n - m$ values. Use bin size 0.01. Also plot the theoretical distribution on the same set of axes.

(b) Use the above distribution to estimate the value of the following definite integral.

$$\int_0^1 e^{-x^2} dx$$