Exercises 1 (7. March 2022)

Monte Carlo technique

1. construct a uniform random number generator from the congruential method:

$$I_{i+1} = mod(a \cdot I_i + c, m)$$

$$R_{i+1} = \frac{I_{i+1}}{m}$$

with $I_0 = 4711$, $a = 205$, $c = 29573$ and $m = 139968$
Compare the correlation of 2 random numbers. Compare this with RANLUX.

2. construct a Gaussian random number generator from a uniform random number generator

3. write a small program that integrates (with Monte Carlo method) the function $f(x) = 3x^2$ for $\int_0^1 f(x)dx$, and calculate the uncertainty.

4. write a small program that integrates (with Monte Carlo method) $\int_0^1 \int_0^x dxdy$ with $0 < x, y < 1$.

5. write a small program to integrate a simple function in one dimension: $\int_{x_{min}}^1 g(x)dx = \int_{x_{min}}^1 (1-x)^5 \frac{dx}{x}$, using Monte Carlo integration, with $x_{min} = 0.0001$
Improve the above integration by using importance sampling.

If you have time, you can do some more exercises:

- use the LHAPDF library to calculate the flavor sum rules:

$$\int_0^1 dx\ u_V(x, Q^2) = 2$$

$$\int_0^1 dx\ d_V(x, Q^2) = 1$$

use the LHAPDF library and calculate the momentum sum rule:

$$\int_0^1 dx \sum_{i=-6}^{6} xp_i(x, Q^2)$$

use the MRST(MRST2004nlo) set and the LO* (MRST2007lomod) set. How much is the momentum sum rule violated in the LO* set ? Is the momentum sum rule satisfied (or violated in the same way) for different Q^2 values (use $Q^2 = 5, 10, 100, 1000$ GeV^2).