In the name of God

# Department of Physics
# Shahid Beheshti University

## COMPUTATIONAL PHYSICS

## Exercise Set 7

## (Due Date: 1402/02/03)

**Random walk:**
For random walk in $1D$, compute $\langle x(N)\rangle$ and $\sigma_N^2$ for following cases:
**A**: Suppose each steps coming form random variable with flat PDF.
**B:** Suppose the probability of step value is a gaussian and to be random, namely: $P(s) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{s^2}{2\sigma^2}\right)$.
Suppose $\sigma = 0.1, 1, 10$.
**C:** Suppose the probability of step value is $p(s) \sim \tanh(s)/s$ and $s \in [-4, 4]$ to be random. The probability of forward jumping is $p_+ = 0.3$ and probability of backward jumping is $p_- = 0.7$.
**D:** According to violin plot, plot the $\langle x(t)\rangle$ for $t = 10$, $t = 100$ and $t = 1000$. Explain your results.
**E:** According to violin plot, plot the $\sigma(t)$ for $t = 10$, $t = 100$ and $t = 1000$. Explain your results.
**F:** Using $p(x(t))$ compute the $p(\sigma^2(t))$ and compare your results with that of illustrated in part D and E.
**Langevin particle:**
Simulate a particle based on Langevin equation and then compute:
**A:** $\langle v(t)\rangle$.
**B:** $\langle v(t)^2\rangle$.
**C:** $\langle v(t_1)v(t_2)\rangle$.
**D:** $\langle x(t)\rangle$.
**E:** $\langle x(t)^2\rangle$.
**F:** $\langle x(t_1)x(t_2)\rangle$.
**G:** $p(v)$.
**H:** Compare all of above parts with theoretical predictions.
**I:** $p(v(t); v(t+\tau))$. What happens if $\tau \to \infty$.

Good luck, Movahed