In the name of God

Department of Physics
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ADVANCED COURSE ON COMPUTATIONAL PHYSICS AND OPTIMIZATION

Exercise Set 6

(Due Date: 1403/02/20)

Random walk:
For random walk in $1D$, compute $\langle x(N)\rangle$ and σ_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