Date: 1402/02/21

In the name of God

Department of Physics
Shahid Beheshti University

COMPUTATIONAL PHYSICS

Second midterm exam

(Time allowed: 3 hours)

NOTE: Send your programs, plots and results to movahedsadegh [at] gmail.com and amitida3513 [at] gmail.com

1. For a random walk in $1D$, suppose the probability of jumping value is given by:

$$p(s) = \frac{1}{5.4}\left(\frac{\cosh(s)}{(s+10)^2} + \tanh(s)\right)^2$$

for $s \in [-4, +4]$.

A: Compute $\langle x(t) \rangle$ and $\sigma_x^2(t)$ and plot them versus t. (10 points)

B: Compare your theoretical results derived in the above part with the numerical simulation results. (Hint: You should use a proper method to generate value for jumping (s) whose PDF is the same as above probability function) (20 points)

C: Compute $M_n(s)$ for $n = 3, 5$ and $\mathcal{K}_n(s)$ for $n = 3, 4, 5$. (10 points)

2. Non-linear Langevin equation: Suppose that

$$\frac{d}{dt} \ln v(t)^{-1} = v(t)\eta(t)$$

where $\langle \eta(t) \rangle = 0$, $\langle \eta(t)\eta(t') \rangle = \delta_D(t - t')$ and $p(\eta) = \mathcal{N}(0, 1)$.

A: Compute $\langle v(t) \rangle$ and $\langle v(t)v(t') \rangle$ for $\tau = |t' - t|$. (Hint: $v(t = 0) = 0.1$) (20 points)

B: Compute the PDF of the local extrema (peaks and troughs) of $v(t)$ and the un-weighted TPCF of local maxima for a generated $v(t)$ for $t \in [1000, 10000]$. Is it possible to generalize your results for any arbitrary time intervals? Why? (20 points)

Good luck, Movahed