

BM4040 Mechanobiology

Assignment 1

Deadline: 30th January 2024

Total marks: 60

Instructions

1. You have to write down the answers to each question clearly.
2. Submit the assignment in PDF format at [this link](#).

Questions

1. (10) We have seen in the class that for uncorrelated noise the average velocity of the particle increases with time if we ignore dissipation. Show that the same holds if the noise is correlated as

$$\overline{F(t_1)F(t_2)} = \Gamma e^{-|t_1-t_2|/\tau}.$$

2. (10) For a microscopic particle in an optical trap its trajectory can be described by

$$m\ddot{x}(t) = -m\gamma\dot{x}(t) + kx(t) + F(t)$$

where the second term on the right-hand side is the restoring force due to the optical trap. If the drag is very high in the system we can ignore the acceleration term to obtain

$$-m\gamma\dot{x}(t) + kx(t) + F(t) = 0$$

Assuming the noise to be uncorrelated over time, obtain the average value of root mean square displacement as a function of time.

3. (20) Two fair dice are rolled, each of which can generate a number between 1 and 6. Consider this a statistical system.
 - (a) How many microstates are there for this system? How many macrostates are there?
 - (b) What is the probability of each macrostate if the dice are rolled many times?
 - (c) Suppose you are told that the sum of the numbers on the two dice is N , calculate the system entropy.
 - (d) Sketch the plot of entropy as a function of N .
4. (20) Estimate the persistence length of DNA, F-actin, and microtubule, at 37°. You can take help from internet or any other source to get information about their mechanical and geometrical properties. But do not forget to cite the sources you have used. You have to show all the details of your calculation.

