HOMEWORK 2

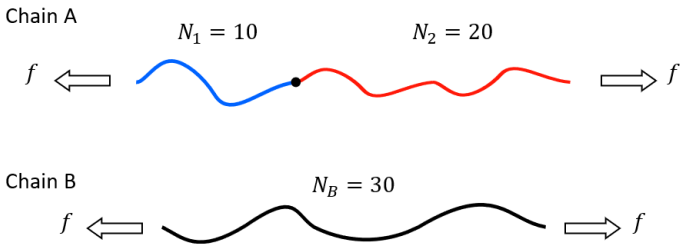
- Show all the work/derivation with neat writing (this counts for the score). Engineering paper should be used. Each student should finish the homework independently.

1. Plot the stiffness K (the derivative of $F-\delta$) of a Langevin chain as a function of Kuhn segment number N, Kuhn segment length b, temperature T and elongation λ. Comment on your findings and explain why there is such dependency.

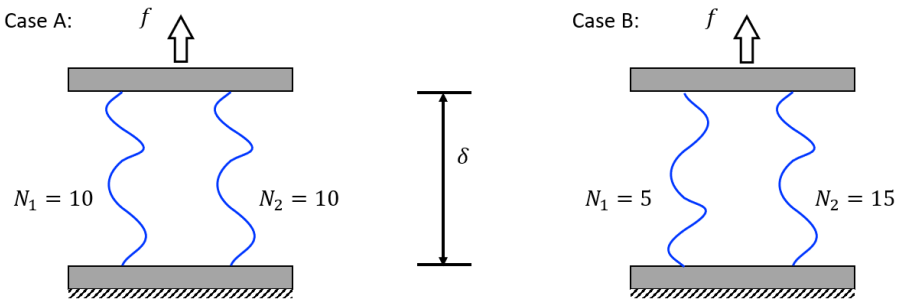
   Hint: Use the polynomial approximation derived in class (first three terms) for the inverse Langevin function.

2. Consider two chains. Chain A is made of two connected Langevin sub-chains of $N_1 = 10$ and $N_2 = 20$ in series. Chain B is also a Langevin chain with Kuhn segment number $N_B = 30$. Plot the force (f)-length (δ) relationship for chain A and B. Are these two plots the same (or not)? Explain your findings.

   Hint: Use the polynomial approximation derived in class (first three terms) for the inverse Langevin function.



3. Consider two rigid plates that are connected by two Langevin chains. For case A, these two Langevin chains have the same Kuhn segment number $N_1 = N_2 = 20$. For case two, they are different as $N_1 = 10$ and $N_2 = 30$. Assume $kT = 1$ and $b = 1$. Consider moving the top plate by a displacement δ.
   i) For each case, plot the force (f)-displacement (δ) relationship.
   ii) The average Kuhn segment of each chain is the same between case A and B. Is the force f also the same (or not)? Comment on this point and explain why.


Case A:
f
$N_1 = 10$
$N_2 = 10$
δ
Case B:
f
$N_1 = 5$
$N_2 = 15$