Statistical Mechanics (32221602): Practical Lab **Sem 6 : COIN TOSSING**
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Experiment-01

1. PRE-REQUISITES
   (a) What is a system ?
   (b) What is an ensemble ? How can you represent the number of ensembles as the number of trials ?
   (c) What is a microstate ?
   (d) What is a macrostate ?
   (e) Postulate : For every coin tossed if p is the probability of head then $q = 1 - p$ is the probability of a tail. For a fair coin we expect $p = q = 1/2$
   (f) Law of large numbers ? Central Limit theorem ?

2. CODING
   (a) Tasks
      i. Coin : Create Random number generator giving binary output $0, 1$ or Boolean T, F
      ii. System : Call the Coin N_c times and generate the microstate and macrostate of the system.
      iii. Ensemble : Call the system N_T (Trials) times, store the microstates & macrostates and generate all three statistical graphs
   (b) Follow the hypothesis that each coin has equal probability of landing on each of its two faces.
      i. Specify the system
         A. A system with large number of coins $N_C = 100$
         B. A system with relatively small number of coins $N_C = 10$
         C. A system with a single coin $N_C = 1$
      ii. Use Inbuilt function to make a random number generator for random choice (each coin having equal probability of landing on each of its faces).
   (c) i. **Trials variation Plot**: Probability Vs number of occurrence of heads for every system with $N_C = 5, 10, 100$ for trials $N_T = 10N_C$, $50N_C$, $100N_C$, $500N_C$, $1000N_C$, $10000N_C$, $100000N_C$.
      Overlay with the **Binomial distribution for comparison in each system**.
      ii. **Coin variation Plot** : Fix the trials as $N_T = 100$ and plot the Freq of heads/Total no. of trials Versus the number of heads for coins $N_C = 1, 2, 3, 4, 5...10$.
      iii. **Cummulative Plot**: Cummulative probability of heads (tails) with Number of events. (i) upto 500 trials for initial fluctuations (ii) upto 10000 trials for complete fluctuations.
      iv. **Add on**: Infer the fluctuations in the cummulative plot with respect to the number of trials. Fluctuations versus N if you can analyse ? If fluctuations show a behaviors as $F \alpha 1/N^k$ what is the k ?

3. APPLICATIONS
   (a) Analyse the random number bias-ness if p and q values change.
   (b) Can you connect the probability with temperature $\propto e^{-\mu B/kT}$. Can you make a system where the system decides the temp. You may consider spins. Look for a system having similar characteristics.