Tribhuvan University
Institute of Science and Technology
SCHOOL OF MATHEMATICAL SCIENCES
First Assessment 2079

Subject: **Monte Carlo Methods** *Full Marks*: 45
Course No: **MDS 607** *Pass Marks*: 22.5
Level: **MDS /II Year /III Semester** *Time*: 2hrs

Candidates are required to give their answers in their own words as far as practicable.

Attempt All Questions.

Group A [3 ×5 = 15]

1. Name the characteristics of good random number generators.
2. Explain the meaning of "Random variables".
3. How do you estimate errors in Monte Carlo methods? Describe.
4. Write down the meaning of transition probabilities with examples.
5. What is "State space"? Explain.

Group B [5 × 6 = 30]

6. Discuss the congruential method to generate random numbers with its algorithm.

OR

How can one test whether random numbers are good? Explain the criteria of good random numbers generators.

7. What is Monte Carlo Method? Discuss its significance.

OR

Distinguish between Simple and importance sampling in Monte Carlo methods of Integration.

8. Explain the meaning of "Markov Chain". Also explore its role in Monte Carlo methods.
9. How do you distinguish "stationary distribution" from other distributions? Explain an algorithm to get "stationary distribution" using Python code.
10. Explore the significance of "Reversible Markov chain".

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Group A [5×3=15]

1. What is Gibbs Sampling? Explain briefly.
2. Distinguish between frequentists and Bayesian inferences.
3. Describe the meaning of "Burn-in" period.
4. Illustrate meaning of "Reparametrization".
5. Define prior distribution in light of "Bayesian Statistics".

Group B [5×6=30]

6. What is the Metropolis-Hastings algorithm and how does it differ from the Metropolis algorithm?

   OR

   Justify Metropolis-Hastings Algorithm to carry on any MCMC.

7. Discuss convergence criteria in Gibbs sampling.

   OR

   Consider bivariate normal distribution. Discuss necessary theory and Algorithm to solve this problem using Gibbs sampling.

8. Discuss the significance of Bayesian inference over other methods of statistics.
9. How do we check for convergence of a Metropolis-Hastings sampler? Discuss with an example.
10. A manufacturer claims that the shipment contains only 5% of defective items, but the inspector feels that in fact it is 10%. We have to decide whether to accept or to reject the shipment based on θ, the proportion of defective parts. Before we see the real data, let's assign a 50-50 chance to both suggested values of θ i.e. $\pi(0.05) = \pi(0.10) = 0.5$. A random sample of 20 parts has 3 defective ones. Calculate the posterior distribution of θ.

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