

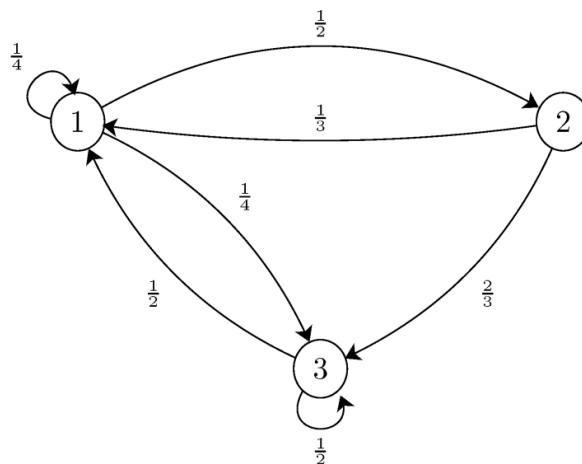
## EE 629: Probability Models and Applications – Coding Test (Autumn 2023)

### Instructions

- 1) Write your own code in MATLAB or PYTHON. Plagiarism rules as per the institute norms.
- 2) Make suitable assumptions wherever necessary.
- 3) Do not use in-built functions to generate Markov chains.
- 4) Submit your files in a single .zip file with the subject line “EE 629 coding test - <Roll No>”.
- 5) Only one submission is allowed.
- 6) The deadline for submission is **Nov. 6<sup>th</sup> 2023 08:00 IST**.
- 7) Late submissions, regardless of how late they are, will get 0 marks.

### Questions

- 1) (10 marks) Use the inverse CDF method to generate 10000 samples of the following random variables
  - a. (5 marks) Exponential random variable with mean equal to  $\mu$ .
  - b. (5 marks) Rayleigh random variable with mean equal to  $2\mu$ .where  $\mu$  = sum of the last three digits of your roll number divided by 10. Compare the results (CDF and PDF) with those obtained using in-built functions for part (a).
- 2) (10 marks) Generate 10000 samples of a RV following a Gaussian distribution with mean  $\mu$  and variance  $3\mu$ , where  $\mu$  = sum of the last three digits of your roll number divided by 10.
  - a. (5 marks) Central limit theorem
  - b. (5 marks) Box-Muller methodCompare the results (CDF and PDF) with those obtained using in-built functions to generate Gaussian RVs.
- 3) (20 marks) Consider an LTI system with the impulse response  $h(t) = e^{-t}$  for  $t \geq 0$  and  $h(t) = 0$ , otherwise. Construct your own WSS random processes  $X_1(t)$  and  $X_2(t)$ . Write code to provide them as inputs to the LTI system and obtain the outputs  $Y_1(t)$  and  $Y_2(t)$ . Write code to prove that the outputs are also WSS.
- 4) (30 marks) Write code to obtain the answer to the following questions.
  - a. (15 marks) **The Amazing Spider-Man:** Green Goblin, an arch nemesis of Spider-Man is located at a corner of a cubical shaped building (say  $(0,0,0)$ ) and is distracted from the world. Spider-Man wants to catch him but is located at the opposite corner (say  $(1,1,1)$ ). To conceal himself, Spider-Man decides to only move along the edges of the cubical shaped building in any direction  $(x,y,z)$  with equal probability  $1/3$ . On an average, how many steps will Spider-Man need to get to Green Goblin?
  - b. (15 marks) Simulate the following Markov chain and determine its limiting distribution.



- 5) (15 marks) Write code to illustrate accept and reject sampling considering  $f(x)$  to be the PMF a fair six-sided dice which you can throw how many ever times you want.
- 6) (15 marks) Write code to illustrate the Markov Chain Monte Carlo (MCMC) technique.

## References

- Accept and Reject Sampling: <https://www.youtube.com/watch?v=OXDqidVVePY>
- MCMC: [https://www.youtube.com/watch?v=yApmR-c\\_hKU&t=11s](https://www.youtube.com/watch?v=yApmR-c_hKU&t=11s)