Stochastic Modeling (MATH3425, HKUST)
Course Outline - 2023-2024 Spring

1 *Instructor & T.A.* .

Instructor: Kani Chen. Email: makchen@ust.hk; Phone: 2358-7425; Office: Room 3426. Office hour: Walk-in or by appointment.

Zoom: in Canvas

TA: Mr Zhenhang Shang (zshangab@connect.ust.hk) and Miss Lifang Zheng (lzhengah@connect.ust.hk)

2 *Textbook & Reference Books*.

Lecture Notes: In the LALA system.

Textbook: An Introduction to Stochastic Modeling. (Academic Press 3rd Edition, 1998, ISBN012848874) by H.M. Taylor and S. Karlin.

(Or: An Introduction to Stochastic Modeling. (Academic Press 4th Edition, 2011, ISBN9780123814166) by M. A. Pinsky and S. Karlin.)

(The above two books are largely one same book, though we use the first one.)

Reference books: 1. Stochastic Modeling and the Theory of Queues. (Prentice-Hall International Edition) by R.W. Wolff. 2. Probability and Random Processes. 2nd edition. (Oxford Science Publications) by G.R. Grimmett & D.R. Stirzaker.

3 *Intended Learning Outcomes*:

Students will understand random processes such as Markov chains, Poisson processes, branching processes, birth/death processes and renewal processes and Brownian motion, and use them as models in real applications.

4 *Gradings and Exams*:

Homework (50%) and Final Exam (50%).

Final exam is open book.

Homework assessment: $0.5c/n + 0.5f(n/N)$, where $f(x) = ((x - 0.05)_+/.95)^{.25}$.

N is the total number of problems listed in the LALA, weighted by difficulty; n is the total number of problems you tried, weighted by difficulty; c is the total number of problems you solved correctly, weighted by difficulty.

For the j-th exercise/problem/DIY problem, listed in the LALA system, its difficulty is $d_j = m_j/(c_j + m_j)$ where c_j (m_j) is the number of students who did the j-th problem correctly (incorrectly). (A special case: $d_j = 1$ if $c_j + m_j \leq 3$.)

5 *Prerequisites*:

Math2421 (Probability) or equivalents.

6 *Tentative Schedules*.

Wk 1. (Ch.1-2, all sections). Review of the fundamentals of probability theory.

Wk 2-5. (Ch.3, sections 3.1-3.4; 3.8-3.9). Introduction to Markov chains: definitions, transition probability matrices, some Markov models, first step analysis; branching processes, branching processes and generating functions.

Wk 6-7. (Ch.4, sections 4.1-4.3). Markov chains: regular transition probability matrices, limit theorems, classification of states.

* Reading: basic limit theorems. (section 4.4).

Wk 8-9. (Ch.5, sections 5.1-5.3). Poisson processes: Poisson distribution and the Poisson process, the law of rare events, distributions,

* Reading: uniform distribution and Poisson processes. (section 5.4).

Wk 10-11. (Ch.6, sections 6.1-6.2). Continuous time Markov chains: birth-death processes.

* Reading: the limiting behavior, finite state continuous time Markov chains. (sections 6.4-6.5).

Wk 12-13. (Ch.7, sections 7.1-7.4). The renewal phenomena: definitions, examples, Poisson process viewed as renewal process, asymptotic theory.

Wk ... (Ch.8, sections 8.1-8.3). Introduction to Brownian motion (if time allows.)

Remark: The above course schedule may be subject to minor changes depending upon the teaching progress.