Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): **MATH 3826 Markov Chain and Queuing Theory (3,3,0)**

Course Aims: This course introduces basic principles, classical models, popular algorithms and various applications in other fields of Queuing Theory and Markov Chain.

Prerequisite: MATH2207 Linear Algebra and MATH2206 Probability and Statistics and MATH3205 Linear Programming and Integer Programming

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Course Intended Learning Outcomes (CILOs):

Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
1	Recognize basic knowledge of Markov chain models
2	Recognize basic knowledge of queuing models
3	Model some application problems in Markov chain models and queuing models
4	Apply algorithms to solve some Markov chain models and queuing models
5	Solve problems independently

Teaching & Learning Activities (TLAs)

CILO	TLAs will include the following:
1,2	**Pre-review the lecture notes** Instructor will release the lecture notes before classes, and so students can pre-review it. Through this way, students can understand the lectures more efficiently and quickly.
1,2,3,4,5	**Discussions on class** Instructor will raise some questions on each class, and the students will be encouraged to solve them. Either individual thinking or group discussions are encouraged. Through this way, the interests of students might be inspired, and their ability of solving problems might be strengthened.
1,2,3,4	**Literature reading** Instructor will assign some high-level research articles on this subject for the students to read, even though their difficulties are beyond the requirement of this course. This reading will broaden the scope of students, and help them appreciate the beauty of this subject better. In addition, it will prepare for more advanced courses in the future.
1,2,3,4,5	**Homework** After the completion of each chapter, instructor will give some assignment questions. This will train the ability of students to solve real problems and strengthen their understanding of the lecture.
1,2,3,4,5	**Lecture** Instructor will introduce the topics of the course's materials in the lectures and examples will be used to demonstrate the introduced methodologies.

Assessment:

No.	Assessment Methods	Weighting	CILO Address	Remarks

No.	Assessment Methods	Weighting	CILO Address	Remarks
1	Continuous Assessment (assignments and test)	40%	1,2,3,4,5	Assignments are designed to measure students understanding of the theory, techniques, and applications of Markov chain models and queuing models. The test is conducted to monitor the students' understanding of the theory, techniques and skills taught in class. This may involve, but not limited to, in class discussions of rigorous technical problems and their solutions.
2	Final Examination	60%	1,2,3,4,5	Final Examination is designed to see how far students have achieved their intended learning outcomes especially in the knowledge domain. Students should have a thorough understanding of the knowledge and apply them correctly in different context to do well in the exam.

Course Intended Learning Outcomes and Weighting:

Content	CILO No.
I. Markov Chains	1,3,4,5
II. Markovian decision process	1,3,4,5
III. Queuing theory	2,3,4,5

Textbooks

1. S. Ross, Introduction to Probability Models, 11th Edition, Elsevier, 2014.
2. D. Gross, C, J. F. Shortle, J. M. Thompson, and C.M. Harris, Fundamentals of Queuing Theory, Wiley, 4th Edition, 2008.

References

1. D. Isaacson and R. Madsen, Markov Chains: Theory and Applications, Wiley, 1976.
2. R. Cooper, Introduction to Queuing Theory, North-Holland, 1981.
3. W. L. Winston, Operations Research: Applications and Algorithms, Brooks/Cole, 2004.
4. H. A. Taha, Operation Research: An Introduction, Pearson Education, 2007.

Course Contents in Outline:

Topics

I Markov Chains
- A Introduction to stochastic process
- B Introduction ro Markoc chain
- C Transition probabilities
- D Steady-state probabilities and mean first passage times
- E Absorbing chains

Topics

F Case study

II Markovian decision process
- A Introduction
- B Finite-stage dynamic programming model
- C Infinite-stage model
- D Linear programming solution
- E Case study

III Queuing theory
- A Modeling arrival and service processes
- B Birth-Death processes
- C The M/M/1/GD/∞/∞ queuing system
- D The M/M/1/GD/c/∞ queuing system
- E The M/M/s/GD/∞/∞ queuing system
- F The M/G/∞/GD/∞/∞ and GI/G/∞/GD/∞/∞ queuing system
- G The M/G/1/GD/∞/∞ queuing system
- H Closed queuing networks
- I Priority queuing Models
- J Transient behavior of queuing systems
- K Case study

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