

**COURSE:** Stochastic Processes in Physics, Chemistry, and Biology  
TuTh 2:30pm-3:45pm in Fine Arts Building #002

**PROFESSOR:** Hye-Won Kang  
Office: Math/Psych Building #424  
Email: hwkang@umbc.edu  
Office Hours: Tuesday and Thursday during 12pm-1pm, or by appointment.  
I will try to respond to all emails in the same day. However during the weekends, I am not available to answer them.

**TEXT:** Stochastic Processes in Physics and Chemistry (Third Edition) by N.G. Van Kampen.  
Textbook is required in class. I will also use a selected set of papers as reading materials.

**COURSE DESCRIPTION:**

This course is an introduction to stochastic processes with applications in Physics, Chemistry, and Biology. Audience of the course is expected to have knowledge in introductory probability. We will cover:

- Markov processes
- The master equation
- The Fokker-Planck equation
- The Langevin equation, and
- Monte Carlo simulation methods.

Stochastic processes will be introduced with connections to applications in physics, chemistry, and biology. Intended audiences are graduate students in mathematics and statistics who are interested in probability and its applications. No previous background in physics, chemistry, and biology is required.

**PREREQUISITE:**

Basic probability or statistics background is required.

**GRADING POLICY:**

Grades are based on homework and class participation. Final letter grade is decided based on the total grade as follows:

Letter Grade	Total Scores
A	$85 \leq \text{Total} \leq 100$
B	$70 \leq \text{Total} < 85$
C	$\text{Total} < 70$

However, factors such as overall distributions of grades will affect on the final letter grade. Contributed portions of the total score are as follows:

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<b>HOMEWORK</b>	<b>CLASS PARTICIPATION</b>	<b>TOTAL</b>
50%	50%	100%

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**HOMEWORK:**

There will be assignments (discussion reports) after class discussion sessions. You are required to turn in your discussion report before the class on the due date. Discussion report should be written based on your summary of the discussion in class and on the summary of the reading materials assigned in the corresponding discussion session. You are encouraged to discuss together but copying from other students is NOT allowed. Also, copying from a solution manual is PROHIBITED. Any violation will result in ZERO grade and will be reported to the University Academic Integrity Committee. Late homework will NOT be accepted.

**PARTICIPATION:**

We plan to have seven discussion sessions. Students are required to be prepared to discuss the assigned reading materials in class. Entire class during discussion session will consist of questions, answers, presentations of students. Your participation during discussion sessions will be graded, and 50% of your grades will be given based on participation.

**ATTENDANCE:**

The attendance is not mandatory, but is highly recommended. Based on the previous experience, students who attend every lecture have a very higher tendency to get a higher score at the end. When you come to the class, you are expected to participate in the class. I ask that you bring a textbook, you are on time, and pay attention to the class. No excuse for being habitually late and the use of smartphones during class is strongly discouraged. Please do not distract yourselves and other students.

**INCOMPLETE:**

If you do complete the course successfully except for a very small portion or a final exam due to very extraordinary and emergence situation (such as to stop attending school for the rest of the semester due to injury in an accident), you will be considered to get Incomplete. You are required to submit a written statement and evidence describing reason to get Incomplete. If the reason to get Incomplete is because you are behind in the course, I would recommend to drop the course, instead.

**ACADEMIC INTEGRITY:**

By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of disciplinary action that may include, but is not limited to, suspension or dismissal. See the Faculty Handbook, or the UMBC Policies section of the UMBC directory. <http://oue.umbc.edu/home/academic-integrity/>

**APPROXIMATE COURSE SCHEDULE:**

This course will cover various topics. The below is the approximate schedule of the course which is subject to change. The changed schedule will be updated regularly on the course web page in Blackboard.

WEEK	DATES	SECTIONS	TOPICS
1	Tu Aug 30 Th Sep 1	Chap 4	No class Markov Processes
2	Tu Sep 6 Th Sep 8	Chap 4 Chap 4	Markov Processes Markov Processes
3	Tu Sep 13	<b>Discussion 1</b>	Discuss an assigned paper
----- <b>Wednesday, September 14, is the last day to withdraw from the course <u>without</u> receiving a 'W' on your transcript.</b> -----			
	Th Sep 15	Chap 5 <b>Homework 1</b>	The Master Equation Discussion 1 report
4	Tu Sep 20 Th Sep 22	Chap 5 Chap 5	The Master Equation The Master Equation
5	Tu Sep 27 Th Sep 29	Chap 5 Chap 5	The Master Equation The Master Equation
6	Tu Oct 4 Th Oct 6	<b>Discussion 2</b> Chap 7 <b>Homework 2</b>	Discuss an assigned paper Chemical Reactions Discussion 2 report
7	Tu Oct 11 Th Oct 13	Chap 7 Chap 7	Chemical Reactions Chemical Reactions
8	Tu Oct 18 Th Oct 20	<b>Discussion 3</b>	Discuss an assigned paper No class
9	Tu Oct 25 Th Oct 27	Chap 8 <b>Homework 3</b> Chap 8	The Fokker-Planck Equation Discussion 3 report The Fokker-Planck Equation
10	Tu Nov 1 Th Nov 3	<b>Discussion 4</b>	No class Discuss an assigned paper
11	Tu Nov 8 Th Nov 10	Chap 9 <b>Homework 4</b> Chap 9	The Langevin Equation Discussion 4 report The Langevin Equation
12	Tu Nov 15	Chap 9	The Langevin Equation
----- <b>Tuesday, November 15, is the last day to withdraw from the course <u>with</u> receiving a 'W' on your transcript.</b> -----			
	Th Nov 17	<b>Discussion 5</b>	Discuss an assigned paper
13	Tu Nov 22 Th Nov 24	<b>Homework 5</b>	Monte Carlo Simulation Discussion 5 report Thanksgiving Day: no class

WEEK	DATES	SECTIONS	TOPICS
14	Tu Nov 29 Th Dec 1	Chap 12	Monte Carlo Simulation Monte Carlo Simulation
15	Tu Dec 6 Th Dec 8	<b>Discussion 6</b>  <b>Homework 6</b>	Discuss an assigned paper Monte Carlo Simulation Discussion 6 report
16	Tu Dec 13 Th Dec 15		Monte Carlo Simulation No class

A list of assigned papers

1. **Discussion 1:** Peter Hänggi and Harry Thomas, “Stochastic processes: time evolution, symmetries, and linear response”, Physics Reports, Volume 88, Number 4, (1982)
2. **Discussion 2:** Michael J. Piling and Struan H. Robertson, “Master equation models for chemical reactions of importance in combustion”, Annual Review of Physical Chemistry, Volume 54, (2003)
3. **Discussion 3:** J. Goutsias and G. Jenkinson, “Markovian dynamics on complex reaction networks”, Physics Reports, Volume 529, (2013)
4. **Discussion 4:** R. Kubo, “The fluctuation-dissipation theorem”, Reports on Progress in Physics, Volume 29, Part 1, (1966)
5. **Discussion 5:** Daniel T. Gillespie, “The chemical Langevin equation”, Journal of Chemical Physics, Volume 113, Number 1, (2000)
6. **Discussion 6:** Daniel T. Gillespie, “Exact stochastic simulation of coupled chemical reactions”, The Journal of Physical Chemistry, Volume 81, Number 25, (1977)