湖北工業大學
HUBEI UNIVERSITY OF TECHNOLOGY

Course Title	Probability
Course Code	MATH 3401
Semester	Summer 2026
Course Length	4 Weeks, 60 Contact Hours
Credits	4
Instructor	TBA
Office	TBA
Email	TBA
Prerequisite	MATH 1122 Calculus II MATH 2231 Multivariable Calculus

Course Description:

This course provides a rigorous, calculus-based foundation in probability theory, preparing students for advanced study in statistics, mathematics, and data science. The curriculum builds from fundamental axioms to sophisticated limit theorems, emphasizing mathematical proof, derivation, and analytical problem-solving. Students will master discrete and continuous random variables, expectation and variance, moment-generating functions, and multivariate distributions. The course culminates in a detailed exploration of convergence concepts, including the Laws of Large Numbers and the Central Limit Theorem, providing a solid theoretical foundation for understanding random phenomena.

Course Goals:

Students who successfully complete this course will demonstrate competency in the following general education core goals:

- **Critical thinking skills** – Students will engage in creative and/or innovative thinking, and/or inquiry, analysis, evaluation, synthesis of information, organizing concepts, and constructing solutions.
- **Communication skills** – Students will demonstrate effective written, oral, and visual communication.
- **Teamwork** – Students will demonstrate the ability to work effectively with others to support a shared purpose or goal and consider different points of view.
- **Social responsibility** – Students will demonstrate intercultural competency and civic knowledge by engaging effectively in local, regional, national, and global communities.

Student Learning Outcomes:

Upon completion of this course, students will be able to:

- Formally construct probability models using set theory and counting techniques, and articulate the axioms of probability;
- Analyze concepts of conditional probability, independence, and Bayes' Theorem, applying them to complex problems;
- Define, classify, and manipulate discrete and continuous random variables using PMFs, PDFs, and CDFs;
- Compute and interpret expectation, variance, and higher moments, utilizing tools such as indicator variables and moment-generating functions;
- Master key discrete and continuous distributions (e.g., Binomial, Poisson, Geometric, Uniform, Exponential, Normal, Gamma), including their properties, relationships, and derivations;
- Model joint probabilistic behavior using multivariate distributions, and compute marginal and conditional distributions;
- Determine the covariance and correlation between random variables and assess statistical independence;
- Prove and apply probabilistic inequalities and limit theorems, interpreting their theoretical significance and practical implications.

Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:

Primary Text: Pitman, J. (1993). *Probability*. Springer.

Supplementary Reference: Ross, S. (2019). *A First Course in Probability (10th ed.).* Pearson.

Course Requirements:

Homework Assignments
Homework assignments are designed to deepen conceptual understanding and develop proficiency in mathematical proof and problem-solving. These problem sets include theoretical derivations, proofs, and challenging applied scenarios.

Quizzes
Short, periodic quizzes will be administered to ensure students are keeping pace with the course material and to provide consistent feedback. These quizzes evaluate comprehension of recent key concepts, definitions, and theorems, encouraging continuous engagement and study throughout the semester.

Midterm Exam
This in-person midterm exam assesses mastery of the course's first half, covering foundational topics such as combinatorial probability, axioms, conditional probability, discrete random variables, and standard discrete distributions. The exam will include a mix of computational problems and theoretical proofs, testing both procedural fluency and conceptual understanding.

Final Exam
This in-person final exam is a comprehensive assessment of all course learning outcomes, with special emphasis on continuous distributions, multivariate distributions, moment-generating functions, and limit theorems. This examination

requires students to synthesize concepts from the entire semester to solve complex problems and prove fundamental results, demonstrating overall mastery of probability theory.

Assessments: Activity	**Percent Contribution**
Homework Assignments	30%
Quizzes	15%
Midterm Exam	20%
Final Exam	35%

Grading:

Final grades will be based on the sum of all possible course points as noted above.

Grade	**Percentage of available points**
A	94-100
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73
D	64-69
D-	60-63
F	0-59

Course Schedule:
The schedule of activities is subject to change at the reasonable discretion of the instructor. Minor changes will be announced in class, major ones provided in writing.

MATH 3401 Schedule

Lecture	Topic	Readings
L1	The Nature of Probability: Sample Spaces and Axioms	Chapter 1
L2	Combinatorial Principles: Permutations and Combinations	Chapter 1
L3	Advanced Counting & Sampling	Chapter 2
L4	Probability Axioms and Properties	Chapter 1
L5	Conditional Probability and Independence	Chapter 1, 6
L6	Bayes' Theorem and Applications	Chapter 1, 6
L7	Discrete Random Variables: PMF, Expectation, Variance	Chapter 3
L8	Standard Discrete Distributions: Bernoulli and Binomial	Chapter 2, 3
L9	Standard Discrete Distributions: Geometric and Poisson	Chapter 3
L10	Other Discrete Models: Negative Binomial, Hypergeometric	Chapter 2, 3
L11	Review & Synthesis of Discrete Probability	-
L12	Continuous Random Variables: PDFs, CDFs, Expectation	Chapter 4
L13	Standard Continuous Distributions: Uniform and Exponential	Chapter 4
L14	The Normal Distribution and Standardization	Chapter 4
L15	Functions of a Random Variable	Chapter 4
/	**Midterm Exam**	/
L16	Joint Distributions: Discrete and Continuous Cases	Chapter 5
L17	Marginal and Conditional Distributions	Chapter 5, 6

L18	Covariance and Correlation	Chapter 6
L19	Sums of Independent Random Variables	Chapter 3, 5
L20	Moment-Generating Functions and Their Properties	Chapter 3, 4, 6
L21	Conditional Expectation	Chapter 6
L22	Probabilistic Inequalities: Markov and Chebyshev	Chapter 3, 4
L23	Laws of Large Numbers and Sampling Distributions	Chapter 3, 4
L24	Central Limit Theorem and Estimation Concepts	Chapter 4, 5
L25	Properties of Estimators and Course Review	Chapter 4, 5
	Final Exam	/

Accommodation Statement:

Academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as he/she is not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow.

Academic Integrity Statement

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in coursework may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records.

Other Items:

Attendance and Expectations

All students are required to attend every class, except in cases of illness, serious family concerns, or other major problems. We expect that students arrive on time, be prepared to listen and participate as appropriate, and stay for the duration of a meeting rather than drift in or out casually. In short, we anticipate that students will show professors and fellow students maximum consideration by minimizing the disturbances that cause interruptions in the learning process. This means that punctuality is a must, that cellular phones be turned off, and that courtesy is the guiding principle in all exchanges among students and faculty. You will be responsible for the materials and ideas presented in the lecture.

Assignment Due Dates

All written assignments must be turned in at the time specified. Late assignments will not be accepted unless prior information has been obtained from the instructor. If you

believe you have extenuating circumstances, please contact the instructor as soon as possible.

Make-Up Work
The instructor will not provide students with class information or make-up assignments/quizzes/exams missed due to an unexcused absence. Absences will be excused and assignments/quizzes/exams may be made up only with written documentation of an authorized absence. Every effort should be made to avoid scheduling appointments during class. An excused student is responsible for requesting any missed information from the instructor and setting up any necessary appointments outside of class.

Access, Special Needs and Disabilities
Please notify the instructor at the start of the semester if you have any documented disabilities, a medical issue, or any special circumstances that require attention, and the school will be happy to assist.