

New Course Request

Indiana University

Indianapolis Campus

Check Appropriate Boxes: Undergraduate credit Graduate credit Professional credit

1. School/Division Science 2. Academic Subject Code STAT
3. Course Number 61900 (must be cleared with University Enrollment Services) 4. Instructor TBA
5. Course Title Probability Theory

Recommended Abbreviation (Optional) _____
(Limited to 32 Characters including spaces)

6. First time this course is to be offered (Semester/Year): Spring 2010
7. Credit Hours: Fixed at 3 or Variable from _____ to _____
8. Is this course to be graded S-F (only)? Yes _____ No X
9. Is variable title approval being requested? Yes _____ No X

10. Course description (not to exceed 50 words) for Bulletin publication: Probability Theory is the Foundation of statistical methodologies, which is fundamental in the practice of science. From this course students will get a precise mathematical understanding of probabilities and sigma-algebras, random weak convergence, characteristic functions, the central limit theorem, Llobesgue decomposition, conditioning, and martingales.
P: STAT 51900

11. Lecture Contact Hours: Fixed at 3 or Variable from _____ to _____
12. Non-Lecture Contact Hours: Fixed at N/A or Variable from _____ to _____
13. Estimated enrollment: 15 of which 100 percent are expected to be graduate students.
14. Frequency of scheduling: annually Will this course be required for majors? yes
15. Justification for new course: New course for the Ph.D. program in biostatistics
16. Are the necessary reading materials currently available in the appropriate library? yes
17. Please append a complete outline of the proposed course, and indicate instructor (if known), textbooks, and other materials.
18. If this course overlaps with existing courses, please explain with which courses it overlaps and whether this overlap is necessary, desirable, or unimportant.
19. A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of the new course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by:

[Signature] Date 10-5-2009
Department Chairman/Division Director

Approved by:

[Signature] Date 10-07-09
Dean

Date _____
Dean of Graduate School (when required)

Date _____
Chancellor/Vice-President

Date _____
University Enrollment Services

After School/Division approval, forward the last copy (without attachments) to University Enrollment Services for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.

61900
STAT 619 PROBABILITY THEORY

Instructor: TBA

Prerequisite: STAT 51900

Credits: 3 (Class: 3, Lab: 0)

This course is designed for second-year graduate students in Biostatistics Ph. D. Program. Students in Bioinformatics, Computer Science, Economics, Engineering, Finance, Mathematics, Statistics etc. will also benefit from the course. The students should have taken STAT 519 Introduction to Probability (3 CR).

COURSE DESCRIPTION AND RATIONALE

Probability Theory is the foundation of statistical methodologies, which is fundamental in the practice of science. How does one learn things scientifically? Typically, one tries to measure something, but often the measurements have errors. One can use probability theory to study how these errors should affect the conclusions.

How is the study of *Probability Theory* fundamental to Ph.D. students in Biostatistics? Let us answer it by means of a practical application in a randomized clinical trial in medicine. Does taking multivitamins make one healthier and live longer? An anecdotal evidence of one person taking a vitamin pill and living healthier than another person not taking any pill is certainly not sufficient. Neither is sufficient a survey of 100,000 people which reveals that those who take pills are healthier than those who don't. What we need is a designed experiment in which the two experimental groups are similar in all respects. One way to form these groups is to flip a coin for each person: heads means the person gets a daily vitamin pill and tails means the person gets a placebo, with neither the subjects nor those evaluating health knowing who is in which group. We can use the laws of probability to show that the two experimental groups will almost certainly be very similar, provided that a large number subjects are used.

EDUCATIONAL OBJECTIVES

Students completing this course will have a precise mathematical understanding of probabilities and sigma-algebras; random variables, distributions, and expected values; inequalities and laws of large numbers; weak convergence, characteristic functions, the central limit theorem, Lebesgue decomposition, conditioning. The level of the course is mathematically rigorous based on measure theoretic probability, but without the unnecessary intricacies of a purely measure theoretic development suitable for a Ph.D. program in Mathematics/Statistics. Students will see ample practical applications of the theory they will learn. Also students will become familiar with the foundational principals that justify statistical methodologies.

COURSE CONTENT

1. Probability measures and their distribution
 - 1.1 Sigma- algebras and classes of sets
 - 1.2 Measure, product measure and probability measure.
 - 1.3 Integral and Its Properties
 - 1.4 Fubini's Theorem, Dominated Convergence Theorem.

2. Random variable, Expectation and Independence
 - 2.1 General definitions
 - 2.2 Properties of mathematical expectation
 - 2.3 Independence
 - 2.4 Basic properties of conditional expectation

3. Convergence concepts
 - 3.1 Various modes of convergence
 - 3.2 Almost sure convergence; Borel-Cantelli lemma
 - 3.3 Uniform integrability; convergence of moments

4. Law of large numbers and Random series
 - 4.1 Weak law of large numbers
 - 4.2 Three-series Convergence theorem
 - 4.3 Strong law of large numbers
 - 4.4 Zero-or-one laws

5. Characteristic function
 - 5.1 General properties.
 - 5.2 Uniqueness and inversion
 - 5.3 Convergence theorems
 - 5.4 Applications

6. Central limit theorem
 - 6.1 Lindeberg-Feller theorem
 - 6.2 Law of the iterated logarithm

7. Martingales and Markov property
 - 7.1 Conditional independence; Markov property
 - 7.2 Basic properties of martingales

TEXTBOOK

Richard. Durrett (2005), *Probability: Theory and Examples* (3rd ed.). Belmont: CA: Duxbury Press. ISBN: 978-0-534-42441-1. Instructor's Solutions Manual on CD (ISBN: 053442452X) provides worked-out solutions to all problems in the text.

RECOMMENDED BOOKS

Patrick Billingsley (1995), *Probability and Measure* (3rd ed.). New York: John Wiley and Sons. ISBN: 978-0-471-00710-4.

A.N. Shiryaev (1996). *Probability*. New York: Springer.

Bert Fristedt and Lawrence Gray (1997), *A Modern Approach to Probability Theory*. Boston, MA: Birkhauser.

K.L. Chung (2001). *A Course in Probability Theory* (3rd ed.). Academic Press.

Jeffrey S. Rosenthal (2003), *A First Look at Rigorous Probability Theory*. River Edge, NJ: World Scientific Publishing Co. ISBN 981-02-4322-7.

A. DasGupta (2008). *Asymptotic Theory of Statistics and Probability*. New York: Springer Science+Business Media. ISBN: 978-0-387-75970-8.

GRADING POLICY

The percentage point distribution will be as follows: Five Homework (10% \times 5=50%), Two In-class Exams (25% each). There will not be any make-up. Letter grades will be determined by referring the students' achieved percentage scores to the following *absolute* scale: A+=[95, 100], A=[90, 94], A-=[85, 89], B+=[80, 84], etc.

Homework

There will be five homework sets. The homework problems will be assigned from the textbook as well as from outside. Completing all homework sets on time is *absolutely essential* in learning the material. So, late homework is not accepted.

Exams

There will be two in-class exams, one about two-thirds way into the semester and the other at the end of the semester. No makeup test is allowed. The exams will be designed to evaluate the student's conceptual understanding of (i) definitions, (ii) results and proofs, and (iii) solutions to problems.

CHEATING AND PLAGIARISM

Academic misconduct will *not* be tolerated and all cases will be reported. Examine the IU Code of Student Rights, Responsibilities, and Conduct at <http://life.iupui.edu/rights/code.html> and in particular examine the rules regarding academic misconduct at <http://registrar.iupui.edu/misconduct.html>. Violations of these rules will result in a grade of "F" (or 0%) for the assignment in question, and may result in an "F" for the course or even expulsion from the university (see http://www.iupui.edu/code/#part_5).

Americans with Disabilities Act:

If you need any special accommodations due to a disability, please contact Adaptive Educational Services located in Joseph T. Taylor Hall (UC), Room 137, (317)-274-3241. For details see <http://www.iupui.edu/~divrsity/aes/>