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, Loebese 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 05-29-09
Department Chairman/Division Director

Approved by: [Signature] Date 06-03-09
Dean

Chancellor/Vice-President

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.

UPS 724 University Enrollment Services Final—White; Chancellor/Vice-President—Blue; School/Division—Yellow; Department/Division—Pink; University Enrollment Services Advance—White
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, Lebesque decomposition, conditioning.
Supporting Document for a New Graduate Course

To: Purdue University Graduate Council
From: Faculty Member: Ben Boukai
Department: Mathematical Sciences
Campus: Indianapolis
Date: 10-7-09
Subject: Proposal for New Graduate Course-Documentation
Required by the Graduate Council to Accompany Registrar's Form 40G

Contact for information if questions arise:
Name: Ben Boukai
Phone Number: 317-274-6926
E-mail: bboukai@math.iupui.edu
Campus Address: 402 N. Blackford St., LD 270

For Reviewer's comments only
(Select One)

Reviewer:
Comments:

Course Subject Abbreviation and Number: STAT 61900
Course Title: Probability Theory

A. Justification for the Course:

- Provide a complete and detailed explanation of the need for the course (e.g., in the preparation of students, in providing new knowledge/training in one or more topics, in meeting degree requirements, etc.), how the course contributes to existing fields of study and/or areas of specialization, and how the course relates to other graduate courses offered by the department, other departments, or interdisciplinary programs.

- Justify the level of the proposed graduate course (50000- or 60000-level) including statements on, but not limited to: (1) the target audience, including the anticipated number of undergraduate and graduate students who will enroll in the course; and (2) the rigor of the course.

B. Learning Outcomes and Method of Evaluation or Assessment:

- Describe the course objectives and student learning outcomes that address the objectives (i.e., knowledge, communication, critical thinking, ethical research, etc.).

- Describe the methods of evaluation or assessment of student learning outcomes. (Include evidence for both direct and indirect methods.)

- Grading criteria (select from dropdown box); include a statement describing the criteria that will be used to assess students and how the final grade will be determined.

Criteria: Exams and Quizzes
Identify the method(s) of instruction (select from dropdown box) and describe how the methods promote the likely success of the desired student learning outcomes.

**Method of Instruction** Lecture

C. **Prerequisite(s):**
   - List prerequisite courses by subject abbreviation, number, and title.
   - List other prerequisites and/or experiences/background required. If no prerequisites are indicated, provide an explanation for their absence.

D. **Course Instructor(s):**
   - Provide the name, rank, and department/program affiliation of the instructor(s).
   - Is the instructor currently a member of the Graduate Faculty? X Yes _ No
      (If the answer is no, indicate when it is expected that a request will be submitted.)

E. **Course Outline:**
   - Provide an outline of topics to be covered and indicate the relative amount of time or emphasis devoted to each topic. If laboratory or field experiences are used to supplement a lecture course, explain the value of the experience(s) to enhance the quality of the course and student learning. For special topics courses, include a sample outline of a course that would be offered under the proposed course.

F. **Reading List (including course text):**
   - A primary reading list or bibliography should be limited to material the students will be required to read in order to successfully complete the course. It should not be a compilation of general reference material.
   - A secondary reading list or bibliography should include material students may use as background information.

G. **Library Resources**
   - Describe the library resources that are currently available or the resources needed to support this proposed course.

H. **Example of a Course Syllabus** (While not a necessary component of this supporting document, an example of a course syllabus is available, for information, by clicking on the link below, which goes to the Graduate School's Policies and Procedures Manual for Administering Graduate Student Programs. See Appendix K.)

(Revised and Approved by the Graduate Council 2/08)
A. Justification for the course:

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.

B. Learning Outcomes and Method of Evaluation or Assessment:

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.

The percentage point distribution will be as follows: Five Homework (10% x 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.
C. Prerequisites:
STAT 519 or STAT 51900

D. Course Instructor(s):
TBA

E. Course Outline
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
F. Reading List

TEXTBOOK


RECOMMENDED BOOKS


G. Library Resources:


H. Example of Course Syllabus: See Attached
STAT 61900 PROBABILITY THEORY

Instructor: TBA
Prerequisite: STAT 519 or 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 or STAT 51900 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


RECOMMENDED BOOKS


GRADING POLICY

The percentage point distribution will be as follows: Five Homework (10%×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/
Information needed to fill in the "New Course Request" form:

Academic Subject Code: BIOS/STAT
Course Number: 61900
Course Title: Probability Theory
First time this course is to be offered: Spring 2010
Credit hours: 3
No variable title and no S-F grades

Course description: 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 variables, distributions, and expected values; inequalities and laws of large numbers; weak convergence, characteristic functions, the central limit theorem, Lebesgue decomposition, conditioning, and martingales.
Contact hours: 3
Estimated enrollment: 15, 100 % graduate.
Justification: a course for the proposed Ph.D. program in biostatistics