

COURSE APPROVAL ROUTING CHECK LIST

1. Course Number: ACM
PSM 650

1st Bulletin 11/5/09
2nd Bulletin 11/19/09

091029

2. Course Title: Random Walks and Brownian Motion
(no more than 70 characters)

Title Abbreviation: Rand Wlk & Brown Mo
For use in Master Schedule (no more than 19 characters)

3. Action: New Course Revision IF Designation WAC

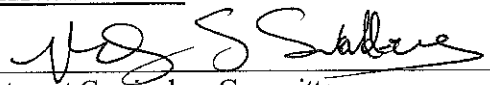
Requested Designation(s): _____

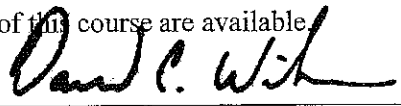
Course Proposal/Revision Check List

This checklist will help departments avoid some of the most common mistakes made on course proposals. Your use of the checklist will allow the College Senate Curriculum Committee to focus its review on more substantive issues and expedite the approval process.

- Proposal format conforms to the Directory of Policy Statements, Section IV:02.00 (2002).
- Proposal has been proofread for spelling, punctuation, grammar, style and gender-neutral language.
- If the course is a new course, reasons for the additions are included; if the course is a revision of an existing course, reasons for revision and a copy of the old course are included as well as the IF Narrative when appropriate.
- Catalog description follows the guidelines in the Curriculum Handbook, Appendix C.
- Student learning outcomes are coherent with course content and assessment.
- Outcomes are referenced with course content.
- All resource entries are alphabetized and conform to a specific style manual.
- Cross listed courses have been checked with all chairs and deans included in development of the course.

DEPARTMENT ACTION

 _____ 10/16/09
Chair, Department Curriculum Committee Date

4. **Approved** with confirmation that all necessary laboratories, studios, resources, facilities and personnel for support of this course are available.
 _____ MATH 10/16/09
Signature of Department Chairperson Department Date

(OVER)

Prefix, Number and Name of Course: PSM 650 Random Walks and Brownian Motion

Credit Hours: 1

In Class Instructional Hours: 1 **Labs:** 0 **Studio:** 0 **Field Work:** 0

Catalog Description:

Prerequisite: Admission to program or instructor permission

Symmetric random walks, ballot theorem, returns to origin and arcsine laws, gambler's ruin, Brownian motion, conditional distributions, hitting times and maxima.

Reasons for Addition:

To create a one-credit-hour module for the graduate Professional Applied and Computational Mathematics program where students will study random walk and Brownian motion problems from a variety of real life situations.

| Student Learning Outcomes: Students will | Course Content Reference: | Assessment: |
|---|----------------------------------|--|
| 1. develop and analyze picturesque theoretical models of real-world random phenomena. | I, II, III, V | Group work in class, individual homework assignments, examinations, and computer projects. |
| 2. derive, describe, and analyze the unexpected and startling properties of the symmetric random walk. | II, IV | Group work in class, individual homework assignments, examinations, and computer projects. |
| 3. design and implement computer simulations to calculate important features of random walks and Brownian motion. | II, III, V, VI | Group work in class, individual homework assignments, and computer projects. |
| Course Content: <ul style="list-style-type: none"> I. Definitions and basic results <ul style="list-style-type: none"> A. Discrete-time, unit-step random walks B. Geometric path interpretations C. Restricted and unrestricted random walks D. Absorbing and reflecting barriers E. Examples (e.g. gambler's ruin) F. Stirling's formula and normal approximation G. Probability generating functions II. Symmetric random walks <ul style="list-style-type: none"> A. Reflection principle and the ballot theorem | | |

- B. First return to the origin
 - C. Arcsine law for last returns to the origin
 - D. Arcsine law for sojourn times
 - E. First passage times
- III. General random walks and the gambler's ruin problem
- A. Absorption probabilities
 - B. Mean duration to absorption
- IV. Random walks in the plane and space: Return-to-origin probabilities
- V. Brownian motion
- A. Limiting value of a symmetric random walk
 - B. Conditional distributions given earlier values
 - C. Conditional distributions given later values
 - D. Hitting times
 - E. Maximum value prior to a given time
 - F. Gambler's ruin in continuous time
 - G. Brownian motion with drift
- VI. Calculating with technology
- A. Simulation of a random walk (generating random numbers)
 - B. Properties from simulated walks (histograms)
 - C. Evaluation of theoretical results (calculating formula values)

Resources

Scholarship:

- Barber, M., *Random and Restricted Walks: Theory and Applications*, Routledge, 1970.
- Berg, H., *Random Walks in Biology*, Princeton University Press, 1993.
- Block, L., *Random Walk*, Backinprint, 2000.
- Doyle, P. and Snell, J., *Random Walks and Electrical Networks*, Mathematical Association of America, 1984.
- Feller, W., *An Introduction to Probability Theory and its Applications*, Vol. 1, 3rd ed., Wiley, 1968.
- Freedman, D., *Brownian Motion and Diffusion*, Holden-Day, 1971.
- Guillot-Plantard, N., and Schott, R., *Dynamic Random Walks: Theory and Applications*, Elsevier, 2006.
- Hughes, B., *Random Walks and Random Environments*, Vol. 1, Oxford University Press, 1995.
- Karatzas, I., and Shreve, S., *Brownian Motion and Stochastic Calculus*, 2nd ed., Springer, 2008.

- Knight, F., *Essentials of Brownian Motion and Diffusion*, American Mathematical Society, 1981.
- Malkiel, B., *A Random Walk Down Wall Street: The Time Tested Strategy for Successful Investing*—[revised and updated], Norton, 2007.
- Nelson, E., *Dynamical Theories of Brownian Motion*, Princeton University Press, 1967.
- Revesz, P., *Random Walk in Random and Non-random Environments*, 2nd ed., World Scientific Publishing Company, 2005.
- Ross, S., *Introduction to Probability Models*, 9th ed., Academic Press, 2007.
- Rudnick, J., and Gaspari, G., *Elements of the Random Walk: An Introduction for Advanced Students and Researchers*, Cambridge University Press, 2004.
- Spitzer, F., *Principles of Random Walk*, 2nd ed., Springer, 2008.
- Telcs, A., *The Art of Random Walks (Lecture Notes in Mathematics)*, Springer, 2006.
- Wiersema, U., *Brownian Motion Calculus*, Wiley, 2008.
- Wilcke, W., *Random Walk*, BookSurge Publishing, 2008.
- Woess, W., *Random Walks on Infinite Graphs and Groups*, Cambridge University Press, 2008.

Periodicals:

- Advances in Applied Probability*
- Annals of Applied Probability, The*
- Annals of Probability, The*
- Applied Stochastic Models and Data Analysis*
- Bernoulli*
- Chance*
- Electronic Journal of Probability*
- Journal of Applied Probability*
- Methodology and Computing in Applied Probability*
- Probability in the Engineering and Informational Sciences*
- Probability Theory and Related Fields*
- Scandinavian Actuarial Journal*
- Stochastic Analysis and Applications*
- Stochastic Processes and Their Applications*

Theory of Probability and Its Applications

Theory of Stochastic Processes

Electronic and/or Audiovisual Resources:

Carter, E.F., "Random Walks, Markov Chains and the Monte Carlo Method,"
<http://www.taygeta.com/rwalks/rwalks.html>.

Chester, M., "Random Walk in One-Dimension,"
<http://www.physics.ucla.edu/~chester/TECH/RandomWalk/>.

Department of Mathematics, University of Utah, "Brownian Motion,"
<http://www.math.utah.edu/classes/217/assignment.04.html>.

Wolfram Research Inc., "Wolfram MathWorld: Random Walk,"
<http://mathworld.wolfram.com/RandomWalk.html>.