COURSE APPROVAL ROUTING CHECK LIST

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

091029

1. **Course Number:** ~~PSM~~ ACM 650

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)

Faculty (Check one)

- ☑ **SNSS** *School of Natural and Social Sciences*
- ☐ **SOE** *School of Education*
- ☐ **SAH** *School of Arts and Humanities*
- ☐ **SOP** *School of Professions*

DEAN'S ACTION

Approved with confirmation that all necessary laboratories, studios, resources, facilities and qualified faculty for support of this course are available.

10/26/09 Karen O'Connor
Date Signature of Dean (both Dean's if cross-listing)

COURSE PACKET INCLUDES:

- ☐ Electronic proposal form
- ☐ Attached electronic document with explanations of contingencies as stipulated at Dean's level
- ☐ One hard copy of proposal with attached contingencies and routing sheet with all appropriate signatures (copy of routing sheet in packet sent to Academic Affairs)
- ☐ For all revisions, one hard copy of current course should be submitted (e-copy is preferable when available)

COLLEGE SENATE ACTION

1. **Received**, logged and electronic packet and hard copies forwarded to the College Senate Office. Program title to be published in the *College Bulletin*.

10/27/09 [signature] 091029
Date Signature of College Senate Office Log Number

2. Action for Intellectual Foundations' Designation

_____ Recommend approval _____
Signature of Assistant Dean, Intellectual Foundations

_____ Recommend disapproval _____
Signature of Assistant Dean, Intellectual Foundations

3. **Action** of the College Senate Curriculum Committee

X Recommend approval and forward to College Senate

11/17/2009 Nancy A. Nicoll
Date Signature of Chair, College Senate Curriculum Committee

_____ Recommend disapproval and return to Department

_____ _____
Date Signature of Chair, College Senate Curriculum Committee

ACTION OF THE OFFICE OF ACADEMIC AFFAIRS

X Approved and forwarded to President [signature] 12/14/09
Signature Date

_____ Disapproved and returned to Department _____ _____
Signature Date

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:

I. Definitions and basic results
   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
   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.

Guillotin-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.