Course Code: F71NP
Full Course Title: Numerical Probability and Monte Carlo
SCQF Level: 11
SCAF Credits: 10
Available as Elective: No

DELIVERY LEVEL
Undergraduate: No  |  Postgraduate Taught: Yes  |  Postgraduate Research: No

COURSE AIMS
The course deals with a rigorous introduction to Monte Carlo methods, and numerical methods to find solutions to stochastic differential equations. These methods are immensely important to understanding financial options price sensitivities (Greeks), and so applications to the techniques discussed will be to finance. Students will be expected to understand both the theoretical content, but also to be able to implement numerical techniques in a programming language such as Matlab.

LEARNING OUTCOMES – SUBJECT MASTERY
On completion of this course, the student will be able to:

1. Be able to simulate random numbers from standard distributions.
2. Be able to use Monte-Carlo techniques to analyse stochastic differential equations.
3. Be able to numerically price basic financial options.
4. Be able to use various numerical schemes to simulate solutions to stochastic differential equations.
5. Be able to use variance-reduction techniques, and to be able to explain their importance.

LEARNING OUTCOMES – PERSONAL ABILITIES

SYLLABUS
Topics covered in the course include: Random number generation, pseudorandom numbers, inversion method, acceptance/rejection method, Box-Muller method, basic Monte Carlo, quasi Monte Carlo. Variance reduction techniques such as: importance sampling, control variates and antithetic random variable, Option price sensitivities (Greeks): pathwise, likelihood and finite difference approaches. Burkholder-Davis-Gundy inequality and Gronwall’s lemma. Strong and weak approximations of solutions to SDEs. Euler's approximations and Milstein's scheme. Order of accuracy of numerical approximations. Higher order schemes, accelerated convergence. Weak approximations of SDEs via numerical solutions of PDEs.

COURSE RELATIONSHIPS
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LOCATION AND ASSESSMENT METHODS
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