

Physical Applications of Stochastic Processes - Video course

COURSE OUTLINE

Probability and statistics: Joint and conditional probabilities and densities. Moments, cumulants, generating functions, characteristic function. Binomial, Poisson, Gaussian distributions. Stable distributions, limit theorems, diffusion limit of random flights. Infinitely divisible distributions.

Stochastic processes: Discrete and continuous random processes. Joint and conditional probability distributions. Autocorrelation function. Markov chains. Discrete Markov processes, master equation. Poisson process, birth-and-death processes. Jump processes. Correlation functions, power spectra. Campbell's Theorem, Carson's Theorem. Thermal, shot, Barkhausen and $1/f$ noise.

Continuous Markov processes: Chapman-Kolmogorov equation, transition rate, Kramers-Moyal expansion. Fokker-Planck equation, backward Kolmogorov equation, first passage and exit time problems. Level-crossing statistics.

Stochastic differential equations: Langevin equation, diffusion processes, Brownian motion, role of dimensionality, fractal properties.

Random walks: Markovian random walks. Random walks and electrical networks, random walks in biology. Levy flights. Self-avoiding walks and polymer dynamics. Random walks on fractals. Non-Markov continuous time random walks.

Randomness in deterministic dynamics: Coarse-grained dynamics, Markov and generating partitions, recurrence statistics.

References:

- Balakrishnan V: Elements of Nonequilibrium Statistical Mechanics (Ane Books). Beck C and Schlogl F:



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Physics

Coordinators:

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Thermodynamics of Chaotic Systems (Cambridge University Press).

- Berg H C: Random Walks in Biology (Princeton University Press).
- Cox D R and Miller H D: The Theory of Stochastic Processes (Chapman and Hall).
- Denker M and Woyczynski W A: Introductory Statistics and Random Phenomena (Birkhauser).
- Doi M and Edwards S F: The Theory of Polymer Dynamics (Cambridge University Press).
- Doyle P G and Snell J L: Random Walks and Electrical Networks (Mathematical Association of America).
- Gardiner C W: Handbook of Stochastic Processes (Springer).
- Grimmett G and Stirzaker D: Probability and Random Processes (Oxford University Press).
- Kac M: Probability and Related Topics in Physical Sciences (Wiley-Interscience).
- Papoulis A: Probability, Random Variables and Stochastic Processes (McGraw- Hill).
- Risken H: The Fokker-Planck Equation: Methods of Solution and Applications (Springer).
- Stratonovich R L : Topics in the Theory of Random Noise, Vols. 1 and 2 (Gordon and Breach).
- Van Kampen N G: Stochastic Processes in Physics and Chemistry (North-Holland).
- Wax N: Selected Papers in Noise and Stochastic Processes (Dover).
- Weiss G H: Aspects and Applications of the Random Walk (North-Holland).
- Wong E: Introduction to Random Processes (Springer).