## ***Applications of probability*** **(M343)** content listing

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| Book 1 | *Probability and random variables* |
| Introduction | Basic concepts and rules of probability, discrete and continuous random variables, expectation, standard distributions, simulation from distributions using random digits, related variables, review of assumed mathematical techniques. |
| Book 2 | *Modelling events in time and space* |
| Part I | Random processes: examples, notation and terminology. |
| Part II | Modelling events in time: Poisson process, multivariate Poisson process, non-homogeneous Poisson process, compound Poisson process, index of dispersion for point processes. |
| Part III | Patterns in space: examples, models for random patterns, clustered patterns and patterns with regularity, counts and distances, tests for randomness in spatial patterns. |
| Book 3 | *Random processes in discrete time* |
| Part I | Branching processes: the Galton-Watson branching process, examples and model, generation sizes, extinction probabilities, extensions and other models. |
| Part II | Random walks: the unrestricted simple random walk, return probabilities and generating functions, general unrestricted random walks, the gambler's ruin problem, random walks with reflecting barriers, limiting distributions, other types of random walks. |
| Part III | Markov chains: finite Markov chains, transition probabilities, limiting distributions and stationary distributions, classification of states, return probabilities and return times – the basic limit theorem, Markov chains with infinite state space. |
| Book 4 | *Random processes in continuous time* |
| Part I | Birth and death processes : the simple birth process, Lagrange's equation and its solution, the immigration-birth process, the pure death process, Markov processes, the Kolmogorov forward equations, the simple birth-death process and embedded random walk, times between events and until various events in these processes, the immigration-birth and immigration-birth-death processes, limiting distributions. |
| Part II | Queues: the simple queue, queue size, queuing distribution, busy periods, general service times, queues with more than one server, general birth and death processes as models for queues, the equilibrium queue size distribution. |
| Part III | Modelling the spread of an infectious disease: the simple epidemic and general epidemic models, deterministic and stochastic models, the threshold phenomenon, the survivor distribution, other models for epidemics. |
| Part IV | More population models: life tables and the life table function, the age-distribution for stationary and stable populations, population pyramids. |
| Book 5 | *Further applications of probability* |
| Part I | Genetics: historical and biological background, Mendel's laws, the Hardy-Weinberg law, sex linkage, examples. |
| Part II | Renewal models: discrete-time renewal processes, generating functions, numbers of renewals and waiting times, continuous-time renewal processes, the ordinary renewal process, waiting times between events, the hazard function, the renewal function, the equilibrium renewal process, total lifetime, residual lifetime, equilibrium renewal density. |
| Part III | Diffusion processes: random walks and diffusion processes, ordinary Brownian motion, waiting times, Brownian bridge, variations including Brownian motion with drift and geometric Brownian motion, other diffusion processes. |