

GRADUATE DIPLOMA IN STATISTICS

MODULE 1: Probability Distributions

READING LIST

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Books

There is no shortage of books about Probability theory. The books discussed here and listed at the end of the document are a selection of all those available, that individually cover much of the syllabus for this Module at an appropriate mathematical level.

A candidate who is unsure of their knowledge of probability might find it helpful to start by working through a more basic textbook that covers many of the ideas in the syllabus at a slower pace or in less mathematical detail. These will typically state (often without proof) the main results for general probability theory, random variables, standard distributions and the central limit theorem, but will not cover other important topics in this Module, such as joint distributions and order statistics. So the candidate will have to move on to a more advanced book in order to cover the whole course at an appropriate mathematical level.

The books listed here generally cover more than the Module 1 syllabus, either further topics in Probability theory (such as concepts in stochastic processes that arise in Module 3) or topics in Statistics (which might be part of the syllabus for Modules 2, 4 or 5). Note, in particular, that the book by Stuart and Ord (2006) is an excellent reference but covers so much material in so much mathematical detail that it is unlikely to be a good place for candidates to start their study of Probability or the only book that a candidate will refer to.

Videos

Many videos illustrating Probability concepts are available on the internet, including videos of lecture courses given by excellent lecturers at top universities around the world. Searching with the search term 'probability' gives over 250,000 videos on *You Tube* and over 2,000,000 on *Google*. A candidate who would like some additional help with any topic in this course will find something by typing it as a search term in these or other search engines.

Demonstrations

A number of web sites offer computer-based demonstrations of topics in Probability, which could be useful to candidates who have access to the underpinning computer package. A good starting point is the impressive list of resources on the *statpages.org* site, <http://statpages.org/javasta4.html>.

Matching the syllabus in detail

Below, the syllabus of Module 1 is written out, section by section, and matched with specific chapters or sections of each of the references in turn. Candidates are advised, however, to choose one or two of these books as their primary textbooks and work through them from start to finish in the first instance. There can be no guarantee that readers would be able to follow any of the books very well if they tried to read them in the order of the Module syllabus rather than in the order the authors intended.

Probability

Sampling with and without replacement. Elementary problems involving urn models. Joint probability, marginal and conditional probability, independence. Law of total probability. Bayes' Theorem.

- DeGroot & Schervish (2012), Chapters 1 – 2
- Grimmett & Welsh (2014), Chapter 1
- Haigh (2013), Chapters 1 – 2
- Hogg, McKean & Craig (2013), Chapter 1
- McColl (2004), Chapter 1
- Ross (2014), Chapters 1 – 3
- Stuart & Ord (2010), 8.1 – 8.21
- Wackerly, Mendenhall & Scheaffer (2007), Chapter 2
- Weiss, Holmes & Hardy (2006), Chapters 1 – 4
- MIT OpenCourseWare, Course 6.041, accessed via www.youtube.com

Distribution theory

Random variables. Discrete and continuous random variables. The probability mass function and probability density function. Cumulative distribution function. Expectation as a linear operator. Expectation of functions of a random variable. Mean and variance. Approximate mean and variance of a function of a random variable. Variance-stabilising transformations.

- DeGroot & Schervish (2012), Chapters 3 – 4
- Grimmett & Welsh (2014), Chapters 2 and 5
- Haigh (2013), Chapter 4.1 – 4.3
- Hogg, McKean & Craig (2013), Chapter 1
- McColl (2004), Chapters 2 – 3
- Ross (2014), Chapters 4 – 5
- Stuart & Ord (2010), 1.1 – 1.29, 3.1 – 3.4
- Wackerly, Mendenhall & Scheaffer (2007), Chapters 3 – 4
- Weiss, Holmes & Hardy (2006), Chapters 5, 7.1 – 7.3, 8 and 10.1 – 10.2

Distribution theory - continued

Standard distributions and their use in modelling, including Bernoulli, binomial, Poisson, geometric, negative binomial, hypergeometric, discrete uniform, Normal, exponential, gamma, continuous uniform, beta, Weibull, Cauchy, lognormal.

- DeGroot & Schervish (2012), Chapter 5
- Grimmett & Welsh (2014), Chapter 2
- Haigh (2013), Chapter 3
- Hogg, McKean & Craig (2013), Chapter 3
- McColl (2004), Chapters 2 – 3
- Ross (2014), Chapters 4 – 5
- Stuart & Ord (2010), 5.1 – 5.19, 5.30 – 5.43
- Wackerly, Mendenhall & Scheaffer (2007), Chapters 3 – 4
- Weiss, Holmes & Hardy (2006), Chapters 5.3 – 5.7 and 8.4 – 8.6

Distribution theory – continued

Joint, marginal and conditional distributions. Independence. Covariance and correlation. The multivariate Normal distribution. Regression; multiple correlation, partial correlation. Knowledge and use of $E(Y) = E(E(Y | X))$. Use of $Var(Y) = E(Var(Y | X)) + Var(E(Y | X))$.

- DeGroot & Schervish (2012), Chapters 3 and 5
- Grimmett & Welsh (2014), Chapters 3 and 6
- Haigh (2013), Chapter 4.4
- Hogg, McKean & Craig (2013), Chapter 2
- McColl (2004), Chapters 4, 5 and 8
- Ross (2014), Chapters 6, 7.5 and 7.8
- Stuart & Ord (2010), 7.1 – 7.26, 7.36
- Wackerly, Mendenhall & Scheaffer (2007), Chapter 5
- Weiss, Holmes & Hardy (2006), Chapters 6, 7, 9 and 10

Distribution theory – continued

Probability generating function. Moment generating function. Applications of generating functions. Distribution of sums of random variables, and of sample mean. Central Limit Theorem.

- Grimmett & Welsh (2014), Chapters 4, 7 and 8
- Haigh (2013), Chapters 5 – 6
- Hogg, McKean & Craig (2013), Chapter 5
- McColl (2004), Chapters 2.3 and 6
- Ross (2014), Chapters 7.7 and 8
- Stuart & Ord (2010), 1.34, 3.5, 11.1 – 11.3, 11.8 – 11.12
- Wackerly, Mendenhall & Scheaffer (2007), Chapters 3 and 7
- Weiss, Holmes & Hardy (2006), Chapter 11
- “fiberclick”, *Convergence of Random Variables* (three videos), accessed via www.youtube.com

Distribution theory – continued

Distributions of functions of several random variables. Transformations, including the probability integral transform. Joint distribution of mean and variance from a Normal random sample.

- DeGroot & Schervish (2012), Chapter 7
- Haigh (2013), Chapter 4.4
- McColl (2004), Chapter 7.1 – 7.2
- Ross (2014), Chapters 6.7 and 7.8
- Stuart & Ord (2010), 1.30 – 1.33, 11.3, 15.1 – 15.9
- Wackerly, Mendenhall & Scheaffer (2007), Chapter 6
- Weiss, Holmes & Hardy (2006), Chapter 9

Distribution theory – continued

The t , χ^2 and F distributions, and their use as sampling distributions.

- DeGroot & Schervish (2012), Chapter 7
- McColl (2004), Chapter 9
- Stuart & Ord (2010), 16.1 – 16.3, 16.11 – 16.12, 16.17 and 16.22
- Wackerly, Mendenhall & Scheaffer (2007), Chapter 7
- Weiss, Holmes & Hardy (2006), Chapter 12

Distribution theory – continued

Joint distribution of order statistics. Distribution of sample range.

- Haigh (2013), Chapter 5.4
- McColl (2004), Chapter 7.3
- Ross (2014), Chapter 6.6
- Stuart & Ord (2010), 10.10 – 10.11, 11.4, 14.1 – 14.7 and 14.23 – 14.26
- Wackerly, Mendenhall & Scheaffer (2007), Chapter 6

Simulation

Generation of uniform pseudo-random numbers; testing for uniformity. Methods of generating random numbers from common distributions, including inversion, rejection and table look-up techniques. Monte Carlo methods. Use of variance reduction techniques. Applications of simulation.

DeGroot & Schervish (2012), Chapter 11

Haigh (2013), Chapter 5.3

McColl (2004), Chapters 3.2 and 7.4

Ross (2014), Chapter 10

Stuart & Ord (2010), 9.1 – 9.27

References

Authors	Year, Edition	Title, ISBN 13	Publisher	Also available
DeGroot, MH & Schervish, MJ	2012 4 th Ed	<i>Probability and Statistics</i> , ISBN 978-0321500465	Addison- Wesley	solutions manual
Grimmett, G & Welsh, D	2014	<i>Probability: An Introduction</i> , ISBN 978-0198709978	OUP	e-book
Haigh, J	2013 2 nd Ed	<i>Probability Models</i> , ISBN 978-1447153436	Springer	e-book
Hogg, RV, McKean, JW & Craig, AT	2013 7 th Ed	<i>Introduction to Mathematical Statistics</i> ISBN 978-0321795434	Pearson	
McColl, JH	2004	<i>Multivariate Probability</i> , ISBN 978-0470689264	Wiley	
Ross, S	2014 9 th Ed	<i>A First Course in Probability</i> , ISBN 978-0321794772	Pearson	
Stuart, A & Ord, K	2010 6 th Ed	<i>Kendall's Advanced Theory of Statistics, Distribution Theory</i> , Volume 1 of Kendall's Advanced Theory of Statistics, ISBN 978-0470665305	Wiley	
Wackerly, D, Mendenhall, W & Scheaffer, R	2007 7 th Ed	<i>Mathematical Statistics with Applications</i> , ISBN 978-0495110811	Cengage Learning	e-book, solutions manual
Weiss, NA, Holmes, PT & Hardy, M	2006	<i>A Course in Probability</i> , ISBN 978-0201774719	Addison- Wesley	solutions manual