ROYAL STATISTICAL SOCIETY

DATA | EVIDENCE | DECISIONS

GRADUATE DIPLOMA IN STATISTICS

MODULE 3 – STOCHASTIC PROCESSES AND TIME SERIES

NOTE: While the RSS has made every effort to ensure that the material and information in this document is accurate and up-to-date when published, it is only general information and may be out-of-date when accessed.

Books for the Stochastic Processes section of syllabus*

Jones and Smith, Pinsky and Karlin** or Ross, Introduction to Probability Models, are texts at about the right level for the module. They also provide suitable revision of the relevant results in probability. Reference should be made to Ross, Stochastic Processes or Grimmett and Stirzaker for deeper coverage of some of the more advanced topics.

Jones P W and Smith P	2009 2nd Ed	Stochastic Processes: an Introduction	Chapman and Hall
Ross S M	2014 11th Ed	Introduction to Probability Models	Academic Press
Grimmett G and Stirzaker D	2001 3rd Ed	Probability and Random Processes	Oxford University Press
Ross S M	1996 2nd Ed	Stochastic Processes	Wiley
Pinsky M A and Karlin S	2011 4th Ed**	An Introduction to Stochastic Modeling	Academic Press

**Early editions were by Taylor and Karlin and contained much of the same content.

Books for the Time Series section of syllabus*

The books by Janacek and by Cryer and Chan would be an excellent starting point, especially on the more practical aspects of the module. Chatfield or Kendall and Ord would also provide good introductory reading, while providing a more wide-ranging and comprehensive text. The books by Box, Jenkins and Reinsel and by Brockwell and Davis are recommended for their thorough treatment and their coverage of the required theory though both extend to advanced topics beyond the syllabus of this module. Bowerman, O'Connell and Koehler is recommended for its coverage of exponential smoothing methods and data analysis but should be complemented by a text which covers the theory.

Bowerman B L, O'Connell R T and Koehler A B	2003 4th Ed	Forecasting, Time Series and Regression	Brooks/Cole
Cryer J D and Chan K-S	2008 2nd Ed	Time series analysis: with applications in R	Springer

Box G E P, Jenkins G M and Reinsel G C	2008 4th Ed	Time Series Analysis: Forecasting and Control	Wiley
Brockwell P J and Davis R A	2006 2nd Ed	Introduction to Time Series and Forecasting	Springer
Chatfield C	2003 6th Ed	The Analysis of Time Series: an Introduction	Chapman & Hall/ CRC Press
Janacek G J	2001	Practical Time Series	Arnold
Kendal, Sir M G and Ord J K	1990 3rd Ed	Time Series	E Arnold

*****Remember earlier editions of these books may have very similar content.

Advice on Reading

This module provides an extended coverage of stochastic processes, including Markov chains and various forms of Poisson processes, and of time series, including ARIMA modelling.

The syllabus concentrates on underlying theory, but applications in various substantive areas are also important and will be represented in examination questions.

The advice below indicates relevant Chapters (and sometimes Sections in brackets) for a selection of the recommended books. Similar material is, of course, available in other textbooks including those on the module booklist. Candidates will be able to get a good idea of the potential range of examination questions by studying the past papers for the module.

Stochastic processes

The references below are to relevant chapters of

Jones & Smith	Jones P W and Smith P	2009 2nd Ed	Stochastic Processes: an Introduction	Chapman and Hall
Pinsky & Karlin	Pinsky M A and Karlin S	2011 4th Ed	An Introduction to Stochastic Modeling	Academic Press
Ross (IPM)	Ross S M	2014 11th Ed	Introduction to Probability Models	Academic Press

- Introduction and general stochastic process models.

Ross (IPM)	Chapter 2.9
Pinsky & Karlin	Chapter 1 (1.1)

- Random walks. Reflecting and absorbing barriers. Mean recurrence time, mean time to absorption. Difference equations. *Use of generating functions.*

Jones & Smith	Chapters 2 & 3
Pinsky & Karlin	Chapter 3 (3.5, 3.6)
Ross (IPM)	Chapter 4 (Examples throughout)

- Branching processes. *Recurrence relations for size of n^{th} generation; probability of extinction.*

Jones & Smith	Chapter 9 (9.1 - 4)

Pinsky & Karlin	Chapter 3 (3.5, 3.6)
Ross (IPM)	Chapter 4 (4.7)

- Markov chain models for discrete-state processes*. Not restricted to finitely many states.* Transition matrices: 1-step and *n*-step. Classification of states. Equilibrium distributions for time-homogeneous chains.

Jones & Smith	Chapter 4
Pinsky & Karlin	Chapters 3 & 4
Ross (IPM)	Chapter 4

- Poisson processes. Differential-difference equations. Birth and death processes

Jones & Smith	Chapters 5 & 6
Pinsky & Karlin	Chapters 5 & 6
Ross (IPM)	Chapters 5& 6

- Queues (1) The M/M/1 queue. Differential-difference equations. Conditions for equilibrium. Equilibrium distributions of queue size and waiting time for first-come-first-served queues. *Equilibrium behaviour for queues with transition rates dependent on queue size.*
  Extensions to M/M/*k* and M/M/∞ queues.
  In examination questions, the word "queue" will refer to all units in a system, i.e. those being served as well as those still waiting to be served.

Jones & Smith	Chapter 7 (7.1 – 4)
Pinsky & Karlin	Chapter 9 (9.1, 9.2, 9.4)
Ross (IPM)	Chapter 8 (8.1 - 3)

- Queues (2) The M/G/1 queue, imbedded Markov chain analysis. The Pollaczek-Khintchine formula. *Equilibrium treatment only.*
  Mean queue length and waiting time.

Jones & Smith	Chapter 7 (7.5 – 7)
Pinsky & Karlin	Chapter 9 (9.3)
Ross (IPM)	Chapter 8 (8.5 – 6)

Time Series

The references below are to relevant chapters of:

Cryer & Chan	Cryer J D and Chan K-S	2008 2nd Ed	Time series analysis: with applications in R	Springer
Janacek	Janacek G J	2001	Practical Time Series	Arnold
Box et al.	Box G E P, Jenkins G M and Reinsel G C	2008 4th Ed	Time Series Analysis: Forecasting and Control	Wiley
Bowerman et al.	Bowerman B L, O'Connell R T and Koehler A B	2003 4th Ed	Forecasting, Time Series and Regression	Brooks/Cole

- Time series models; trend and seasonality. *Additive and multiplicative models.*

Cryer and Chan	Chapter 3
Bowerman et al	Chapters 6 &7
Janacek	Chapter 1 (1.1)

- Stationarity. Autocovariance, autocorrelation and partial autocorrelation functions. Correlograms.

Cryer and Chan	Chapters 2 & 6 (6.2)
Janacek	Chapter 3
Box et al.	Chapter 2 (2.1)
Bowerman et al.	Chapters 6 (6.6) & 9

- Autoregressive (AR) processes. Moving average (MA) processes. ARMA processes. *Yule-Walker equations. Invertibility conditions.*

Cryer and Chan	Chapters 4 & 6 (6.2)
Janacek	Chapter 3
Box et al.	Chapters 1 & 3
Bowerman et al.	Chapters 6 (6.6) & 9

- ARIMA processes and Box-Jenkins methods. *Identification, estimation, checking, forecasting. Box-Pierce and Ljung-Box statistics.*

Cryer and Chan	Chapters 5 to 9
Janacek	Chapters 3 and 5
Box et al.	Chapters 4 to 8
Bowerman et al.	Chapters 6, 9 & 10

- Forecasting and minimising expected prediction variance. *Exponential smoothing, Holt-Winters.*

Janacek	Chapter 2
Bowerman et al.	Chapter 8
Box et al.	Chapter 5
Cryer and Chan	Chapter 9 (9.7)

- Introduction to frequency domain analysis. Spectral density function. Periodograms. *Candidates will be expected to have some familiarity with the fast Fourier transform.*

Cryer and Chan	Chapters 13 & 14
Janacek	Chapters 6 & 7
Box et al.	Chapter 2 (2.2)

April 2015