MODULE TITLE	Stochastic Processes	**CREDIT VALUE**	15
MODULE CODE	MTH3024	**MODULE CONVENER**	Dr Kyle Wedgwood (Coordinator)

DURATION: TERM	1	2	3
DURATION: WEEKS	0	11 weeks	0

Number of Students Taking Module (anticipated)	100

DESCRIPTION - summary of the module content

A stochastic process is one that involves random variables. A large number of practical systems within industry, commerce, finance, biology, nuclear physics and epidemiology can be described as stochastic and analysed using the techniques developed in this module. The systems considered may exist in any one of a finite or possibly countably infinite, number of states. The state of a system may be examined continuously through time or at fixed and regular intervals of time.

You will study processes whose changes of state through time are governed by probabilistic laws, and you will learn how models of such processes can be applied in practice. Module MTH1004 Probability, Statistics and Data is an essential prerequisite, while MTH2006 Statistical Modelling & Inference is desirable.

Prerequisite module: MTH1004 Probability, Statistics and Data or equivalent.

AIMS - intentions of the module

The probability models considered in this module have a common thread running through them: that the behaviour of the system under consideration depends only on the state of the system at a particular point in time and a probablistic description of how the state of the system may change from one point in time to the next. The systems considered may exist in any one of a finite (or possibly countably infinite) number of possible states and the state of the system may be examined continuously through time or at fixed (and regular) intervals of time. A large number of practical systems within industry, commerce, finance, biology, nuclear physics and epidemiology, can be described and analysed using the techniques developed in this module.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module you should be able to:

Module Specific Skills and Knowledge:
1. Demonstrate enhanced methodologies for tackling probabilistic problems;
2. Show awareness of a number of processes and systems whose behaviour through time are governed by probabilistic laws;
3. Construct and apply models describing that behaviour.

Discipline Specific Skills and Knowledge
4. Exhibit familiarity with the concept of random behaviour and the facility to analyse queues - skills which will be applied in later modules;
5. Display enhanced facility with the fundamental mathematical techniques of finite and infinite summation, and of differential and integral calculus.

Personal and Key Transferable / Employment Skills and Knowledge:
6. Reveal enhanced analytical skills, numerical skills, reasoning skills, problem-solving skills, time-management skills and facility to understand complex and abstract ideas.

SYLLABUS PLAN - summary of the structure and academic content of the module

- Probability generating functions (PGFs): definition, basic properties and illustrative examples of PGFs;
- moments of random sums of random variables;
- branching processes: definition, PGF and moments of the population in generation n of a branching process;
- probability of ultimate extinction;
- stochastic size of original population;
- Poisson processes: definition;
- memoryless property;
- Erlang distribution of time to the nth event;
- Poisson distribution of number of events in a given period of time;
- binomial distribution of number r of events in t given n in T;
- beta distribution of time t to rth event given n events in T;
- combining and decomposing independent Poisson processes;
- queueing theory: differential equations for the transient behaviour of models with state-dependent Markov arrival and departure processes;
- derivation of the steady state behaviour of this model;
- existence conditions for steady state;
- specific queueing models: fixed arrival rate, finite source population, customer baulking behaviour, one or more servers, finite system capacity, non-queueing systems which can be modelled as queues;
- mean number of customers in the system/queueing;
- mean time spent in the system/queueing;
- statement and proof of Little's formula;
- distribution of time spent in system/queueing given first come first served;
- Markov processes: Markov property;
- time homogeneity;
- stochastic matrices;
- Chapman-Kolmogorov equations;
- classification of states: accessible, communicating, transient, recurrent, periodic, aperiodic;
- Ergodic Markov chains;
- renewal theorem;
- mean recurrence time;
- necessary/sufficient conditions for the system to tend to a steady state;
- random walks: definition of a random walk with absorbing/reflecting/elastic barriers;
- statement of, solution for and mean time to finish for the Gambler's Ruin problem.

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	33.00	**Guided Independent Study**	117.00	**Placement / Study Abroad**

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description

Category	Hours of study time	Description
Scheduled learning and teaching activities	33	Lectures/example classes
Guided independent study	117	Guided independent study

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Coursework – example sheets		All	Tutorial sessions during lectures/office hours, written feedback on work.

SUMMATIVE ASSESSMENT (% of credit)

Coursework	20	Written Exams	80	Practical Exams	

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Coursework – problem sheets	20		All	Written
Written exam – closed book	80	2 hours (Summer)	All	Written/verbal on request

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-reassessment
Written Exam *	Written exam (100%)	All	August Ref/Def period
Coursework *	Coursework	All	August Ref/Def period

*Please refer to reassessment notes for details on deferral vs. Referral reassessment

RE-ASSESSMENT NOTES

Deferrals: Reassessment will be by coursework and/or written exam in or deferred element only. For deferred candidates, the module mark will be uncapped.
Referrals: Reassessment will be by a single written exam worth 100% of the module only. As it is a referral, the mark will be capped at 40%.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

ELE – http://vle.exeter.ac.uk

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Jones P.W. and Smith P.	Stochastic Processes: methods and applications		Arnold	2001	000-0-340-80654-0	[Library]
Set	Ross, Sheldon M	Introduction to Probability Models	10th	Elsevier	2010	978-0123756862	[Library]

CREDIT VALUE	15	ECTS VALUE	7.5

PRE-REQUISITE MODULES	MTH1004
CO-REQUISITE MODULES	

NQF LEVEL (FHEQ)	6	AVAILABLE AS DISTANCE LEARNING	No
ORIGIN DATE	Tuesday 10 July 2018	LAST REVISION DATE	Thursday 26 January 2023

KEY WORDS SEARCH	Scochastic processes; probability models; Markov process.