# Module Specification

Markov Chains

Version: 2021-22, v1.0, 29 Sep 2020

## Contents

## Part 1: Information

**Module title:** Markov Chains

**Module code:** UFMFSV-15-2

**Level:** Level 5

**For implementation from:** 2021-22

**UWE credit rating:** 15

**ECTS credit rating:** 7.5

**Faculty:** Faculty of Environment & Technology

**Department:** FET Dept of Engineering Design & Mathematics

**Partner institutions:** None

**Delivery locations:** Frenchay Campus

**Field:** Engineering, Design and Mathematics

**Module type:** Standard

**Pre-requisites:** None

**Excluded combinations:** None

**Co-requisites:** None

**Continuing professional development:** No

**Professional, statutory or regulatory body requirements:** None

## Part 2: Description

**Overview:** A Markov chain is a stochastic process, i.e., a sequence of random variables, for which, given the current state, the past contains no additional information concerning the future evolution of the system. In other words, the future states depend on the history of the process only via the current state. From a probabilistic viewpoint, Markov chains constitute a relatively simple class of stochastic processes, but, nevertheless, they provide a very important mathematical

tool for modelling a wide variety of real-world situations. Markov chains have applications in, for example, the following diverse areas: business; economics; engineering; finance; forecasting; manufacturing; music; technology; science; sociology; sport.

This module would be a good option for a student who wishes to develop their knowledge of probability theory, who wants to engage with applications to real-world problems, and who might contemplate a final year project in some area of probabilistic modelling.

**Features:** Not applicable

**Educational aims:** The aim of the module is to introduce the theory, application and simulation of discrete-time, homogeneous Markov chains on a countable state space.

Students will develop their understanding of Markov chains, both theoretical and in applications, through active problem-based learning.

Relevant probability theory and techniques will be introduced as necessary.

**Outline syllabus:** Probability spaces, random variables and conditional probability.
Definitions and basic properties of Markov chains.
Existence of Markov chains (statement only).
Calculation of n-step transition probabilities.
Communicating classes, closed classes, absorption, and irreducibility.
Classification of states.
Hitting times and stopping times.
Recurrence and transience.
Simple random walks in low dimensions.
Simulation of Markov Chains.

## Part 3: Teaching and learning methods

**Teaching and learning methods:** The teaching and learning strategy will involve taught material that is interspersed with individual or group activities that develop understanding of the theory and of its applications. The activities will include computations and simulations within a framework of problem-based learning. It is envisaged that a single multi-purpose room, e.g., a TEAL space, will be utilised for all the contact sessions.

**Module Learning outcomes:**

**MO1** Identify and compute features of Markov chains that have a finite or countable state space.

**MO2** State the properties of Markov chains and related theorems clearly and precisely.

**MO3** Use appropriate software to construct and to run simulation models based on Markov chains.

**MO4** Communicate the features and applications of Markov chains to mathematical and non-mathematical audiences.

**Hours to be allocated:** 150

**Contact hours:**

Independent study/self-guided study = 114 hours

Face-to-face learning = 36 hours

Total = 150

**Reading list:** The reading list for this module can be accessed at readinglists.uwe.ac.uk via the following link https://rl.talis.com/3/uwe/lists/5525BE02-A50E-40BF-D3A5-0314884C15C6.html?lang=en-GB&login=1

## Part 4: Assessment

**Assessment strategy:** The assessment will have two components, namely a one-hour in-class test and a two-hour examination. The in-class test (Component B) will assess the first third of material and will therefore provide feedback to students as to

their early achievement. Specifically, the test will assess an activity involving the use of appropriate software tools to simulate Markov chains and to investigate their properties.

Component A involves an end-of-module controlled conditions event and will involve a mixture of unseen and partially seen questions.

The resit assessment will have the same format as that of the first sit.

**Assessment components:**

**Examination (Online) - Component A** (First Sit)
Description: Online examination
Weighting: 75 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2, MO4

**In-class test - Component B** (First Sit)
Description: One-hour In-class test.
Weighting: 25 %
Final assessment: No
Group work: No
Learning outcomes tested: MO1, MO2, MO3, MO4

**Examination (Online) - Component A** (Resit)
Description: Online examination
Weighting: 75 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2, MO4

**In-class test - Component B** (Resit)
Description: one hour written test

Weighting: 25 %

Final assessment: No

Group work: No

Learning outcomes tested: MO1, MO2, MO3, MO4

## Part 5: Contributes towards

This module contributes towards the following programmes of study:

Mathematics [Sep][FT][Frenchay][3yrs] BSc (Hons) 2020-21

Mathematics [Sep][SW][Frenchay][4yrs] BSc (Hons) 2020-21