

## COURSE SPECIFICATION DOCUMENT

<b>Academic School/Department:</b>	Science, Innovation & Technology
<b>Programme:</b>	Mathematics and Data Science
<b>FHEQ Level:</b>	5
<b>Course Title:</b>	Game Theory and Decision Methods
<b>Course Code:</b>	MATH 5103
<b>Total Hours:</b>	160
Timetabled Hours:	45
Guided Learning Hours:	15
Independent Learning Hours:	100
<b>Credits:</b>	16 UK CATS credits 8 ECTS credits 4 US credits

### **Course Description:**

This course introduces game theory and covers the core principles of game theory and its role in the process of strategic decision-making methods in business, economics, and social sciences. The use of game algebra and the analysis of the structure of various types of practical decision problems as applied especially to business environments will be emphasized. The areas to be studied will include strategic decision making under uncertainty for both non-probabilistic and probabilistic scenarios, risk analysis, Bayes' Theorem, decision trees, systems of linear equations and basic matrix methods, linear programming, Markov Processes, game strategies, game trees, the Nash equilibrium, and classification of games as sequential-move games and simultaneous-move games to include mixed strategy games, the prisoner's dilemma, zero-sum and two-persons games, and hawk-dove games. Detailed applications to specific strategic situations such as in bargaining, bidding and market competition will be explored.

### **Prerequisites:**

40 credits + MATH 4101 Probability and Statistics

## **Aims and Objectives:**

The module aims to:

- Provide students with an introduction to the terminology of game theory and a detailed illustration of what constitutes a game in game theory.
- Explore core principles of game theory and its role in the process of strategic decision-making methods in business, economics, and social sciences.
- Introduce the concept of Nash equilibrium in strategic decision making.
- Investigate and analyze different classifications of games as sequential-move games and simultaneous-move games to include mixed strategy games, prisoner's dilemma, zero-sum and two-persons games, and hawk-dove games.
- Provide examples of the use of game algebra and the analysis of the structure of various types of practical decision problems as applied especially to business environments.
- Present situations involving strategic decision making under uncertainty for both non-probabilistic and probabilistic scenarios, and risk analysis.
- Apply Bayes' Theorem, and decision trees to make strategic decisions with sample information.
- Apply linear programming and Markov Processes in making strategic decisions.
- Explore applications of game theory to specific strategic situation such as in bargaining, bidding, conflict and cooperation, and market competition will be explored.

## **Programme Outcomes:**

L5 AI, AII, BI, BII, CI, CII, DI, DII

A detailed list of the programme outcomes is found in the Programme Specification. This is maintained by Registry and located at: <http://www.richmond.ac.uk/programme-and-course-specifications/>

## Learning Outcomes

By the end of this course, successful students should be able to:

- Understand what constitutes game theory and differentiate different types of games that are appropriate for different situations.
- Identify game theory as a generalization of decision methods, and to think critically about potential applications of game theory to decision problems in business and social science.
- Apply linear programming, Baye's Theorem, Markov Processes and Game Theory in analyzing decision problems, arriving at an optimal decision strategy and exploring data use to make decisions using linear programming and simplex methods.
- Select appropriate game theory methods such as Nash equilibrium, repeated games, evolutionary games and their applications in different scenarios such as in markets and competition, bidding strategy and auctions, bargaining and negotiations.

## Indicative Content:

- Systems of Linear Equations and Matrix Methods. Analytical and Graphical Linear programming.
- Statistical decision theory, decision making under uncertainty and Baye's strategies.
- Use of sample data in decision making using prior and posterior probability distributions.
- Markov process and related states and fundamental matrix.
- Basic ideas of games theory, strategic games and how to think about strategic games. Characteristics of two-person zero-sum game, the game matrix, mixed strategies and graphical solution of  $2 \times n$  games.
- The Nash Equilibrium and its applications.
- Repeated and evolutionary games and the principles and applications of the prisoners dilemma, collective-action games, the hawk-dove games, cooperative games, bidding strategy and bargaining and applications to markets and competition.

## Assessment:

This course conforms to the University Assessment Norms approved at Academic Board and located at: <https://www.richmond.ac.uk/university-policies/>

### **Teaching Methodology:**

This course will be delivered face to face through a combination of lectures and interactive sessions. In addition to classroom activities, there are guided learning elements that are tutored and arranged through Blackboard. These activities can be asynchronous online sessions, flipped classrooms, set readings with discussion boards or set guest lectures for example. Set activities are monitored by the instructor to ascertain student engagement. Students are encouraged to prepare for class and to play an active part, to raise questions, following-up ideas and interact with a wide range of provided material.

### **Indicative Text(s):**

Anderson, D. R., Sweeney, D. J., Williams, T. A. and Martin, K. (2017) *An Introduction to Management Science: Quantitative Approaches to Decision Making*. 15th edn. London: CENGAGE.

Carmichael, F. (2005) *A Guide to Game Theory*. Financial Times Prentice Hall.

Dixit, A., Skeath, S. and McAdams, D. (2025) *Games of Strategy*. 6th edn. New York: W.W. Norton & Company.

Dixit, A., Barry, J. and Nalebuff, J. (2010) *The Art of Strategy: A Game Theoretic Guide to Success in Business and Life*. New York: W.W. Norton & Company.

### **Journals**

International Journal of Game Theory.

Journal of Game Theory

### **Websites**

Game Theory Society. Available at: <https://gametheorysociety.org/journals/> (Accessed: November 2024).

**Change Log for this CSD:**

Nature of Change	Date Approved & Approval Body (School or AB)	Change Actioned by Academic Registry
First Edition	Nov 2024	