

Graphs, games and designs (MST368) – Content listing

Book A – Graphs	
Unit A1 <i>Introduction to Graphs</i>	A graph is a collection of points, or <i>vertices</i> , joined by lines, or <i>edges</i> , and this unit gives a general introduction to these. We discuss Eulerian and Hamiltonian graphs and related problems; one of these is the well-known Königsberg bridges problem.
Unit A2 <i>Trees</i>	Trees are graphs occurring in areas such as branching processes, decision procedures and the representation of molecules. We discuss their mathematical properties and their applications, such as to the minimum connector problem and the travelling salesman problem.
Unit A3 Planarity and colouring	When can a graph be drawn in the plane without crossings? Is it possible to colour the countries of any map with just four colours so that neighbouring countries have different colours? These are two of several apparently unrelated problems considered in this unit.
Book B – Networks	
Unit B1 Network flows	This unit is concerned with connectivity in graphs and digraphs. For example, what is the maximum amount of a commodity (gas, water, passengers) that can pass between two points of a network in a given time?
Unit B2 Networks 2	Optimal paths, packing and scheduling How do you plan a complex engineering project encompassing many activities? This application of graph theory is called ‘critical path planning’.
Unit B3 Networks 3	Matchings and assignment If there are ten applicants for ten jobs and each is suitable for only a few jobs, is it possible to fill all the jobs? This unit considers problems where we need to ‘pair off’ people or objects from two distinct groups, subject to certain constraints.
Book C – Games	
Unit C1 Introduction to games	You’ll learn the basics of game theory, and take a closer look at strategies to win some recreational games, such as Nim.
Unit C2 Zero-sum games	Here you will study games where what one player wins is equal to what the other loses. The main result is von Neumann’s theorem, which tells us that there is always a solution to such games.
Unit C3 General games and Nash equilibria	We consider how to solve games in general, using an idea called Nash equilibrium, and we look at applications to topics such as evolutionary biology and economics.

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Book D - Designs	
Unit D1 Latin squares	Sudoku is a puzzle which is internationally popular. A completed Sudoku is an example of a Latin square, and this unit discovers the mathematics behind these arrays of symbols.
Unit D2 Error-correcting codes	When we send a message through a system where errors or interference can occur, how do we ensure that the recipient receives the same message as we sent? Solving this problem is the topic of coding theory.
Unit D3 Block designs	If an agricultural research station wants to test different varieties of a crop, how should we arrange the crops to minimise bias due to variations in, for example, the soil and sunlight? The answer lies in the study of block designs