AMSI Online: Honours and Masters Subject Guide

Association Schemes

Semester 2, 2026

Administration and contact details

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Subject details

Handbook entry URL	**https://www.handbooks.uwa.edu.au/unitdetails?code=MATH4033**
Subject homepage URL	**https://lms.uwa.edu.au/ultra/courses/_114149_1/outline**
Honours student hand-out URL	**N/A**
Teaching period (start and end date):	**July 20 – October 16 (2026)**
Exam period (start and end date):	**October 24 – November 7 (2026)**
Contact hours per week:	**3**
AMSI Online enrolment close date:	
Lecture day(s) and time(s):	**Wednesday 12pm – 1pm (AWT)** **Friday 12pm – 2pm (AWT)**
Description of electronic access arrangements for students (for example, LMS)	**LMS Blackboard Ultra, MS Teams**

Subject content

1. **Subject content description**
   Association schemes arose the statistical design of experiments, and nowadays can be thought of as a combinatorial structure that generalises linear codes, combinatorial designs, generously transitive permutation groups, and distance-regular graphs. In this course, we will first set the scene with a primer on algebraic graph theory, then a detour to the theory of linear codes and combinatorial designs, with finally a thorough theoretical development of the theory of association schemes.

2. **Week-by-week topic overview**
   Week 1: Introduction to algebraic graph theory
   Week 2: Walks on graphs, cospectral graphs, strongly regular graphs
   Week 3: More on strongly regular graphs, Bose-Mesner algebra, Krein parameters, clique bounds
   Week 4: Designs, Fisher's inequality, quasi-symmetric designs, linear codes, Sphere Packing Theorem
   Week 5: Introduction to association schemes
   Week 6: Intersection algebra, P-polynomial association schemes
   Week 7: Hamming and Johnson schemes, dual distribution, linear programming bound, some applications
   Week 8: T-designs, clique bounds, applications
   Week 9: Design-orthogonality, applications
   Week 10: Spherical codes, applications
   Week 11: Orbital graphs of permutation groups, Terwilliger algebra (if enough time)
   Week 12: More applications, revision.

3. **Assumed prerequisite knowledge and capabilities**

   Linear algebra is a must, in particular, diagonalisation and the Spectral Theorem.
   Basic group theory is helpful, but not essential.

4. **Learning outcomes and objectives**

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

- Define and explain the basic concepts and terminology related to association schemes.

- Identify and analyse the properties of association schemes.

- Apply association schemes to solve problems in combinatorial designs and coding theory.

- Investigate the connections between association schemes and other mathematical structures.

- Demonstrate critical thinking and problem-solving skills through the application of association schemes in practical scenarios.

Learning Outcome Descriptors at AQF Level 8
Knowledge
K1: coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines
K2: knowledge of research principles and methods
Skills
S1: cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence
S2: cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas
S3: cognitive skills to exercise critical thinking and judgement in developing new understanding
S4: technical skills to design and use in a research project
S5: communication skills to present clear and coherent exposition of knowledge and ideas to a variety of audiences
Application of Knowledge and Skills
A1: with initiative and judgement in professional practice and/or scholarship
A2: to adapt knowledge and skills in diverse contexts
A3: with responsibility and accountability for own learning and practice and in collaboration with others within broad parameters
A4: to plan and execute project work and/or a piece of research and scholarship with some independence

5. Learning resources

A course in combinatorics, van Lint & Wilson

Spectra of graphs, Brouwer & Haemers

Association schemes, Bailey

6. Assessment breakdown

Exam	45 %
Assignments	20 %
Mid-semester Test	35 %

Assignment due dates	**Exam date (approximate)**
Assignment 1: August 19	October 30
Mid-semester Test: August 28 (approx)	
Assignment 2: October 7	

Institution honours program details

Weight of subject in total honours assessment at host department	**12.5%**
Thesis/subject split at host department	**50% coursework (4 units), 50% thesis**
Honours grade ranges at host department	
H1	80 - 100 %
H2a	70 - 79 %
H2b	60 - 69 %
H3	50 - 59 %

Institution masters program details

Weight of subject in total masters assessment at host department	**N/A**
Thesis/subject split at host department	
Masters grade ranges at host department	
H1	Enter range %
H2a	Enter range %
H2b	Enter range %
H3	Enter range %