

AMSI Online: Honours and Masters Subject Guide

Association Schemes

Semester 2, 2026

Administration and contact details

Host department	Department of Mathematics and Statistics
Host institution	The University of Western Australia
Name of lecturer	A/Prof John Bamberg
Phone number	08 64887173
Email address	John.Bamberg@uwa.edu.au
Homepage	https://research-repository.uwa.edu.au/en/persons/john-bamberg/
Name of honours coordinator	A/Prof Adriano Polpo
Phone number	08 64883890
Email address	Adriano.Polpo@uwa.edu.au
Name of masters coordinator	N/A
Phone number	N/A
Email address	N/A

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 %