Mathematics Honours Courses for Semester 1, 2009

Department of Mathematics – Macquarie University

First Half	Second Half
Analysis	Partial Differential Equations
Topology	Number Theory
Algebra	To be determined

First Half

Analysis

Time: Tuesday 11 am - 1 pm, Room: E7A333
Lecturer: Xuan Duong - Office: E7A 307

This course presupposes MATH 339 (Real and Functional Analysis) as the background and aims to give students a solid foundation for further study in Pure and Applied Mathematics. Some topics are treated with certain depth. We will study Lebesgue integration, positive Borel measures, and the all important function spaces L^p. Then we will study the elementary Hilbert space theory and Banach space techniques. We also plan to discuss bounded and unbounded linear operators together with their spectral properties.
Prerequisite: MATH339
Text books: Rudin *Real and Complex Analysis* (topics 1–5); Reed & Simon *Functional Analysis* (topic 6).

Topology

Time: Thursday 10 am - 12 noon, Room: E7A333
Lecturer: Ross Street - Office: E7A 311

Topology is the study of continuity. The definition of topological space was conceived in order to say what it means for a function between such spaces to be continuous. There are several different ways of defining topological structure and the proofs that these are equivalent abstract many concrete results about specific kinds of spaces. Different ways of expressing continuity are obtained. Sequences are not adequate for general topological spaces, they need to be replaced by nets or filters, and we discuss convergence of those. Particular properties of topological spaces are analyzed in detail: these include separation properties, compactness, connectedness, countability conditions, local properties, metrizability, and so on. Applications to basic calculus are emphasized. A little bit of algebraic topology may be included by discussing the Poincaré or fundamental group of a space.
Prerequisite: MATH300

Algebra

Time: 23 Feb. to 4 May: Monday 11 am - 1 pm in Room E7A333 and 2pm - 3pm in E7B 161
13 May to 6 June: Wednesday 11 am - 1 pm in Room E7A333 and 2pm - 3pm in E7B 161
Lecturer: Chris Cooper - Offices: E7A 303

This honours unit devotes approximately half of its time to ring theory and half to representation theory, over the complex numbers, for finite groups. The ring theory half provides a grounding in non-commutative ring theory leading, in a somewhat round-about way, to the Wedderburn Structure Theorem for semi-simple algebras. It does not take the most direct path but rather develops some general radical theory before focusing on the nil-radical. The Wedderburn theorem is applied to (classical) representation theory, establishing the orthogonality of irreducible characters that was taken as a given in the MATH337 introduction. The theory of characters is then extended, with a brief excursion into the theory of algebraic integers, to include such methods as inducing characters from subgroups. Finally this character theory is applied to show that groups of order $p^a.q^b$ are soluble. As well as gaining a good theoretical knowledge of representation theory students develop considerable skill in calculating character tables of groups with few normal subgroups, not so much for its own sake but as a way of integrating their knowledge of the theory.
Prerequisite: MATH337