Program	Type of studies (cycle)	Third cycle
	Name of the program	SEE Doctoral Studies in Mathematical Sciences

Course

Course title	**Algebraic Combinatorics**			
Course code	Semester	Course status	ECTS credits	Contact hours
PMAT 655				30

Teaching staff	Teacher	
	Other staff	Doc. Dr. Primož Šparl

Course goals	The main theme of the course is algebraic combinatorics, with particular emphasis being given to algebraic graph theory. This part of discrete mathematics provides a natural setting for many important applications as well as nice formulations of problems arising not only in other areas of mathematics, but other fields of science (biology, chemistry, computer science or physics, ...) too. Focus is on combinatorial objects admitting certain specific degrees of symmetry, thus allowing fruitful applications of various algebraic methods enhanced with certain combinatorial and topological tools as well. Special emphasis is also given to the use of software packages such as MAGMA or GAP. These packages are designed to solve computationally hard problems in algebra, combinatorics, geometry and number theory.

Course content/topics

- Symmetries of combinatorial objects
- Group actions
- Coherent configurations and association schemes
- Designs and their symmetries
- Automorphism groups of graphs
- Symmetric graphs – graphs satisfying specific symmetry properties (vertex-transitivity, edge-transitivity, arc-transitivity, half-arc-transitivity)
- Constructions of symmetric graphs
- Structural properties of symmetric graphs (hamiltonicity, semiregularity, (im)primitivity)
- Combinatorial maps and their symmetries

LITERATURE

[1] N.L. Biggs: Algebraic Graph Theory, Cambridge Univ. Press, 1994.

[2] N. L. Biggs, A. T. White: Permutation Groups and Combinatorial Structures, Cambridge University Press, Cambridge, 1979.

[3] W. Bosma, J. Cannon and C. Playoust, The MAGMA Algebra System I: The User Language, J. Symbolic Comput. 24 (1997) 235-265.

[4] P. J. Cameron. Permutation Groups. LMS Student Text 45. Cambridge University Press, Cambridge, 1999.

[5] J. D. Dixon, B. Mortimer, Permutation Groups, Springer-Verlag, New York, 1996.

[6] C.D. Godsil: Algebraic Combinatorics, Chapman & Hall, 1993.

[7] C. Godsil, G. Royle: Algebraic Graph Theory, Springer, New York, 2001.

[8] H. Wielandt, Finite Permutation Groups, Academic Press, New York, 1964.

[9] The GAP Group, GAP - Groups, Algorithms, and Programming, Version 4.4.12; 2008. (http://www.gap-system.org).

Grading

	Criterion	Points	Cut-off points
1.	Homework assignment	40	22
2.	Project	0	0
3	Final exam	60	33
	Total	100	55

Optional Literature:

B. Alspach, J. Liu, On the Hamilton connectivity of generalized Petersen graphs, Discrete Math. 309 (2009), 5461–5473.

M. Conder, P. Dobcs ́anyi, Determination of all regular maps of small genus, J. Combin. Theory Ser. B 81 (2001), 224

E. Dobson, H. Gavlas, J. Morris and D. Witte, Automorphism groups with cyclic commutator subgroup and Hamilton cycles, Discrete Math. 189 (1998), 69-78.

S. Evdokimov, I. Ponomarenko, Permutation group approach to association schemes, Europ. J. Combin. 30 (2009), 1456-1476

M. Giudici, Quasiprimitive groups with no fixed point free elements of prime order, J. London Math. Soc. (2) 67 (2003), 73–84.

L. Lovasz, Combinatorial structures and their applications, (Proc. Calgary Internat. Conf., Calgary, Alberta, 1969), pp. 243-246, Problem 11, Gordon and Breach, New York, 1970.

A. Malnic, Group actions, coverings and lifts of automorphisms, Discrete Math. 182 (1998), 203-218.

M. Muzychuk, I. Kov ́acs, A solution of a problem of A. E. Brouwer, Des. Codes Cryptogr. 34 (2005), 249–264.

C. E. Praeger, Quotients and inclusions of finite quasiprimitive permutation groups, J. Algebra 269 (2003), 329-346.

R. B. Richter, J.Siran, R. Jajcay, T.W. Tucker and M. E. Watkins, Cayley maps, J. Combin. Theory Ser. B 95 (2005), 189-245.

P.Sparl, A classification of tightly attached half-arc-transitive graphs of valency 4, J. Combin. Theory Ser. B 98 (2008), 1076-1108.