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C O M B I N A T O R I C S

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General Announcements

Under this heading we publish short news items for the information of members. All contributions should be sent to Professor R.W. Robinson, Department of Mathematics, University of Newcastle, N.S.W. 2308.

VISITORS :

Dr. John van Rees from Dept. of Computer Science University of Manitoba to University of Newcastle, August 1980. Contact Prof. W.D. Wallis.

Dr. Curt Lindner from Auburn University Alabama to University of Newcastle, July-August 1980. Contact Prof. W.D. Wallis.

Mr. Chris H. Rowley from Open University to University of Western Australia, July-Sept. 1980.

Prof. H. Tverberg from University of Bergen, Norway, to A.N.U. from August, 1980.

NEW ADDRESSES :

Dr. Les Foulds, Operations Research, University of Canterbury, Private Bag, Christchurch, New Zealand.

Dr. Louis Caccetta, School of Mathematical and Physical Sciences, Murdoch University, W.A. 6153.

MARRIAGE :

Congratulations are extended to Elizabeth Morgan and David Billington who were married in June. Liz is now Dr. Elizabeth Jane Billington.

COMBINATORICS CONFERENCES :

The Eighth Australian Conference on Combinatorial Mathematics, Geelong, Victoria, Australia, 25-29 August, 1980. See the Third Notice in this issue.

The Fourth Bonn Workshop of Combinatorial Optimisation 28-30 August, 1980. Topics include discrete and combinatorial optimisation, graph theory, matroids, independence systems, polyhedral combinatorics, analysis of combinatorial algorithms. Contact Insititut für Ökonometrie und Operations Research, Rheinische Friedrich-Wilhelms-Universität Bonn, Nassestrasse 2, D-5300 Bonn 1, Federal Republic of Germany.

The Tenth Manitoba Conference on Numerical Mathematics and Computing, 1-4 October, 1980, Winnipeg. Invited speakers include Brendan McKay, J.H. Wilkinson. Contact Department of Computer Science, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada.

The Third Caribbean Conference in Combinatorics and Computing, 5-8 January 1981, Cave Hill campus of University of West Indies, Barbados. Invited speakers include Prof. Read and Prof. Churchhouse. Contact Prof. C.C. Cadogan, Department of Mathematics, University of West Indies, P.O. Box 64, Bridgetown, Barbados, West Indies.

Convexity and Graph Theory Conference, 16-19 March, 1981, Haifa (16-17) Beer Sheva (18-19), Israel. Contact Prof. Mosche Rosenfeld, Department of Mathematics, Ben Gurion University of the Negev, P.O. Box 653, Beer Sheva 84120, Israel; or Prof. Joseph Zaks, Department of Mathematics, University of Haifa, Mount Carmel, Haifa 31999, Israel.

The Sixth Hungarian Colloquium on Combinatorics, Budapest, Hungary, 6-11 July 1981. Conducted by János Bolyai Mathematical Society. Proceedings will be published. Contact E. Györi, Secretary Combinatorics, J. Bolyai Mathematical Society, H-1368 Budapest, Pf.240., Hungary.

The Eighth British Combinatorial Conference, 20-24 July, 1981, Swansea. Contact Prof. H.N.V. Temperley, Department of Applied Mathematics, University College, Swansea SA2 8PP, Wales.

CHINESE COMBINATORICS :

Alan Brace (Canberra C.A.E.) visited China recently with Prof Moran (A.N.U.), Prof van der Poorten (Macquarie), Prof. Robertson (Murdoch) under the auspices of the Academy of Sciences and the Australia-China Scientific Exchange Scheme. He reports that combinatorics and graph theory is now being taught in Chinese universities with Bondy and Murty, Theory of graphs with applications, Macmillan the favourite text. Research is also being done in various institutes. Alan will elaborate in his talk at the 8 A.C.C.M.

BRITISH COMBINATORIAL BULLETIN :

This bulletin is published by the British Combinatorial Committee once a year about November or December. The 1979-80 Bulletin contains lists of British combinatoricists, addresses, research students, lecture courses, published work. Subscription is one pound sterling for two issues. Send it to the editor, Dr. Mike Ganley, Department of Mathematics, University of Glasgow, University Gardens, Glasgow G12 8QW, Scotland.

Kalamazoo Conference 1980

The Fourth International Conference on the Theory and Applications of Graphs was held at Western Michigan University, Kalamazoo, from May 6th to May 9th this year. It was dedicated jointly to E.A. Nordhaus, on his retirement, and F. Harary, on his 60th birthday (in a year's time).

A rather full programme was divided between 20 minute talks, 45 minute talks and long hours of R & R. To give some idea of the time available for the latter task, the first day's events started with registration at 8.30 a.m. and finished with cocktails at 9.00 p.m. There were short breaks for food in midstream. The full programme resulted from a laudible effort on the organisers' parts to avoid concurrent sessions. Perhaps an extra day, though, may have taken off some of the pressure.

To give some idea of the quality of the performers, main talks were given by L.W. Beineke, P. Erdos, R.L. Graham, F. Harary, G. Ringel, F.S. Roberts, C. Thomassen, W.T. Tutte and R.J. Wilson. But many of the shorter timeslots were also filled by people of some note.

Theory generally dominated applications, but F. Harary and James Joyce (a grandson of the J.J.) nobly applied graph theory to mediaeval texts. On the theory side almost everyone's favourite topic was covered with perhaps a little more emphasis on connectivity, colouring and Ramsey theory than on other areas.

During the conference the weather was generally fine, although at times it was quite crisp. A few days after the conference downtown Kalamazoo was devastated by tornadoes. There must a moral there somewhere.

- *D.A. Holton*

Higher Degrees

Supervisors of higher degree theses on combinatorial mathematics in Australasian institutions are invited to send details - recipient's name, supervisor's name, degree, date awarded, institution, title, abstract - to Dr. Shiela Williams, Dept. of Mathematics, University of Queensland, St. Lucia, Queensland 4067, Australia.

A previous list appeared in *Combinatorics* Vol.1, No.2. Another list is planned for *Combinatorics* Vol.2, No.3.

	Student Degree Date Awarded	Supervisor Institution	Title Abstract reference
1.	BONG, Nguyen Huu Ph.D. 1970	J.B. Miller Monash	Some combinatorial and spectral properties of Baxter Operators. Bull.Austral.Math.Soc. 4(1971) 285-286.
2.	BRUNNER, A.M. Ph.D. 1973	R.M. Bryant B.H. Neumann A.N.U.	Fibonacci sequences and graph theory Bull.Austral.Math.Soc. 9(1973) 473-474.
3.	CLARK, Garry J. M.Sc. 1976	A.F. Horadam, U. of New England	The Existence and Construction of Balanced Incomplete Block Designs.
4.	GRANT, Douglas D. M.Sc. 1974	D.A. Holton U. of Melbourne	The stability index of graphs.
5.	IAKIN, Adriano L. M.Sc. 1975	A.F. Horadam U. of New England	Aspects of the Sequence $W_n(a,b;p,q)$.

6.	McAVANEY, Kevin L. M.Sc. 1974	D.A. Holton U. of Melbourne	Stability and enumeration.
7.	McKAY, Brendan D. M.Sc. 1976	D.A. Holton U. of Melbourne	Backtrack programming and the graph isomorphism problem.
8.	PECKHAM, Ian A. M.Sc. 1973	D.A. Holton U. of Melbourne	The hamiltonian product of graphs
9.	WALLIS, Jennifer S. M.Sc. 1969	W.J. Ewens La Trobe U.	Hadamard matrices
10.	SHANNON, Anthony Greville M.A. 1972	A.F. Horadam U. of New England	Application of Techniques of L. Carlitz to some Recurrence Relations.
11.	SHANNON, Anthony Greville Ph.D. 1975	A.F. Horadam U. of New England	Some Number Theoretic Properties of Arbitrary Order Sequences. Bull. Austral. Math. Soc. 14 (1976), 149-151.
12.	WALTON, Jamie Edward M.Sc. 1968	A.F. Horadam U. of New England	Properties of Second Order Recurrence Relations.

ABSTRACTS :

D.D. Grant, The stability index of graphs.

The basic problem in this thesis is as follows: In what ways are the symmetry of a graph and the symmetries of its subgraphs related? Two facets of this question are surveyed and investigated: fixing subgraph and stability index.

A characterisation of semi-stable graphs is given and the stability properities of trees and unicyclic graphs are considered. A concise proof is given that a non-trivial tree or unicyclic graph is stable if and only if its automorphism group contains an automorphism of the form (uv). It is shown that if T is a tree of n vertices, s.i.(T) = n, n - 5, n - 7 or 0. The index-0 unicyclic graphs are determined.

The balance of the thesis investigates the relation between stability and various operations on traphs. Conditions on G_i are given so that s.i.$(\bigcup_{i=1}^{n} G_i) > 0$. A number of compositions of particular graphs (e.g. $T[K_n]$, T a tree, $G[K_n]$, G stable, $C_m[K_n]$) are shown to be stable.

A list of unsolved problems is appended.

I.A. Peckham, The hamiltonian product of graphs.

Let the graphs G_i have hamiltonian path h_i and $|VG_i| = n_i$, for $i = 1, 2$. Label the vertices from 0 to $n_i - 1$ in order along h_i. We define the hamiltonian product of G_1 and G_2 to be the graph on $VG_1 \times VG_2$ such that $(u, v) \sim (\bar{u}, \bar{v})$ if and only if either

(i) $u = \bar{u}$, $v \sim \bar{v}$,
or (ii) $u \sim \bar{u}$, $v = \bar{v}$,
or (iii) $\bar{u} = u+1 \pmod{n_1}$, $\bar{v} = v + 1 \pmod{n_2}$
or (14) $\bar{u} = u - 1 \pmod{n_1}$, $\bar{v} = v - 1 \pmod{n_2}$.

An inconclusive investigation is made of the conditions under which two hamiltonian products are equal.

An investigation is made of the automorphism group of the hamiltonian products of G_1 and G_2 in terms of G_1 and G_2. This group is determined when $G_1 = G_2$.

J.S. Wallis, Hadamard matrices.

A Hadamard matrix is an orthogonal matrix all of whose entries are ± 1. It is not known whether Hadamard matrices exist for all orders divisible by 4. However several infinite classes are known to exist. The existence of four new classes is proved; and new constructions of Hadamard matrices are derived which generalize some classes known to Williamson.

B.D. McKay, Backtrack programming and the graph isomorphism problem.

A large class of backtrack programs are described and methods by which an associated automorphism group can be used to improve efficiency are investigated. The results are applied to the problem of canonically labelling a graph, producing an algorithm which can canonically label a graph and produce a set of less than n generators for its automorphism group, where n is the number of vertices. It is believed that the new algorithm allows a more efficient implementation than does previous algortihms, and is almost optimal for large random graphs. A much improved version of the algorithm can be found in B.D. McKay, "Computing automorphisms and canonical labellings of graphs", Combinatorial Mathematics, Lecture Notes in Mathematics No. 686, pp. 223-232.

K.L. McAvaney, Stability and enumeration.

A *cactus* is a connected graph all of whose blocks are cycles or K_2. It is shown that a cactus of a certain type is stable if and only if its automorphism group contains an automorphism of the form (uv). Further all five index-0 cacti of this type are determined.

All trees and unicyclic graphs with a single cycle automorphism are enumerated using Polya-type methods. Consequently the number of stable trees and unicyclic graphs are determined. All trees with a double cycle automorphism are characterised and enumerated.

New Publications

Authors are invited to send details of publications on appearance to Dr. D.A. Holton, Department of Mathematics, University of Melbourne, Parkville, Vic., 3052.

B. Alspach, K. Heinrich and B.N. Varma, Decompositions of complete symmetric digraphs into the oriented pentagons, *J. Austral. Math. Soc.*, 28, 1979, 353-361.

S.O. Macdonald and A.P. Street, Balanced binary Arrays II: The triangular grid, *Ars. Comb.*, VIII, 1979, 65-84.

J.H. Mason and J.G. Oxley, A circuit covering result for matroids, *Math. Proc. Cambridge Philos. Soc.*, 87, 1980, 25-27.

S. Oates-Williams and A.P. Street, Balanced binary arrays III: The hexagonal grid, *J. Austral. Math. Soc.*, 28, 1979, 479-498.

James G. Oxley, Colouring, packing and the critical problem, *Quart. J. Math. Oxford*, 29, 1978, 11-22.

James G. Oxley, Cocircuit covering and packings for binary matroids, *Math. Proc. Cambridge Philos. Soc.*, 83, 1978, 347-351.

James G. Oxley, Infinite matroids, *Proc. London Math. Soc.*, 37, 1978, 259-272.

James G. Oxley, Infinite matroids and duality, *Problèmes combinatories et thèorie des graphes*, Colloques Internationaux C.N.R.S. No. 260, C.N.R.S., Paris, 1978, pp. 325-326.

James G. Oxley, On a packing problem for infinite graphs and independence spaces, *J. Combin. Theory Ser. B*, 26, 1979, 123-130.

James G. Oxley and D.J.A. Welsh, The Tutte polynomial and percolation, *Graph theory and related topics*. Edited by J.A. Bondy and U.S.R. Murty (Academic Press, New York, San Francisco, London, 1979) pp. 329-339.

James G. Oxley and D.J.A. Welsh, On some percolation results of J.M. Hammersley, *J. Appl. Probability*, 16, 1979, 526-540.

James G. Oxley, On cographic regular matroids, *Discrete Math.*, 25, 1979, 89-90.

S.P. Mohanty and D. Rao, Characterization and enumeration of hypotraversable graphs. *Bull. Austral. Math. Soc.*, 20, 1979, 437-446.

M.J. Pelling and D.G. Rogers, Stein quasigroups II : algebraic aspects, *Bull. Austral. Math. Soc.*, 20, 1979, 321-344.

J.M. Plotkin and J. Rosenthal, Some asymptotic methods in combinatorics, *J. Austral. Math. Soc.*, 28, 1979, 452-460.

J. Seberry, A note on orthogonal Graeco-Latin designs, *Ars. Comb.*, VIII, 1979, 85-94.

J. Seberry, Some infinite classes of Hadamard matrices, *J. Austral. Math. Soc.*, 29, 1980, 235-242.

K. Stacey and D.A. Holton, Vertex-deleted subgraphs of lexicographic products, *Ars. Comb.*, VIII, 1979, 163-184.

R.G. Stanton and S.A. Vanstone, Some theorems on DK designs, *Ars. Comb.*, VIII, 1979, 117-130.

D.J. Street, Generalized Hadamard matrices, orthogonal arrays and F-Squares, *Ars. Comb.*, VIII, 1979, 131-142.

S.A. Vanstone, Resolvable (r, λ) - designs and the Fisher inequality, *J. Austral. Math. Soc*, 28, 1979, 471-478.

M. Watanabe and A.J. Schwenk, Integral starlike trees, *J. Austral. Math. Soc.*, 28, 1979, 120-128.

E.G. Whitehad Jnr., Four discordant permutations, *J. Austral. Math. Soc.*, 28, 1979, 369-377.

N. Wormald, Some problems in the enumeration of labelled graphs. *Bull. Austral. Math. Soc.*, 21, 1980, 159-160.

Research Announcements

Please send contributions to Dr. D.A. Holton, Department of Mathematics, University of Melbourne, Parkville, Vic., 3052. *An asterisk indicates that preprints of that article are available.*

* D.A. Holton and M.D. Plummer, Cycles through prescribed and forbidden point sets.

* D.A. Holton, Cycles through prescribed vertices in k-connected regular graphs.

Definition of Combinatorial Mathematics

The editor still awaits your definitions as requested in *Combinatorics* Vol. 2, No. 1.

A Survey of Undergraduate Courses in Combinatorics and Graph Theory Taught in Australia and New Zealand

Prepared by
Charles H.C. Little
Royal Melbourne Institute of Technology Ltd.
Melbourne, Vic. 3000
Australia

On the suggestion of the editor, I have undertaken a survey of undergraduate courses in combinatorics and graph theory taught in Australia and New Zealand. Letters were sent to all universities and most colleges in the two countries asking for relevant details. As many of the readers of this article will be people who sent me such information, I take this opportunity to thank them.

This article examines the relevant courses on a state-by-state basis. I have included syllabi for most of the courses.

I. QUEENSLAND

The teaching of combinatorics and graph theory in Queensland is based at two institutions, the Capricornia Institute of Advanced Education and the University of Queensland, which offers a large number of courses which contain some combinatorics.

(1) Capricornia Institute of Advanced Education

Graph Theory III: introduction, matrices on a graph, cycles and cutsets, types of graph, numbers on a graph, fundamentals, computation of distances, location of centres, planar graphs, planarity vs. non-planarity, genus and thickness, map colouring, absorbent and independent sets, set matching and covering, enumeration of trees and spanning trees, Menger's theorem and connectivity, maximum flow through a graph, flowgraph algorithms, Euler and Hamilton paths, travelling salesmen and their problems, tournaments, hypergraphs. Time allotted: 22 lectures. Assessment: 20% assignment, 80% 3-hour "open book" exam. Texts: external studies notes, Christofides, Wilson.

Capricornia also has a third year project in graph theory, and more projects are planned. For further details, contact J.D. Smith.

(2) University of Queensland

As the Dept. of Computer Science teaches combinatorics and graph theory at the post-graduate level only, a description of their courses is not given here. The courses below are all taught in the Department of Mathematics. Each course lasts for one semester.

MP205 Finite Mathematics II: elementary combinatorial theory, Boolean algebra, elementary graph theory, introduction to grammars and their associated languages. Time allotted: 2 lectures and 1 tutorial/week. This course is usually taken in the first semester of second year. According to the Dept. of Mathematics Handbook, it "is designed both for mathematics and for computer science students, and covers topics on discrete structures relevant to the Association for Computing Machinery Curriculum 78."

MP306 Combinatorial Analysis III: graph theory, Pólya counting theory, method of inclusion and exclusion, transport networks, block designs, algebraic coding theory. Time allotted: 2 lectures and 1 tutorial/week. This course is usually taken in the second year of an Honours course or the third year of a Pass course. In the past, the class has consisted of pure mathematics, statistics or computer science students. MP205 is a prerequisite.

MP475 Combinatorics: topics chosen from: graph theory, enumeration theory, transport networks, block designs, algebraic coding theory, theory of cyclotomy.

In addition, the following courses contain some combinatorics, but are not taught with that emphasis.

MA107 Operations Research I: linear optimisation in 2 and 3 dimensions, convex sets, network models, branch and bound, topics from sequencing and scheduling, computer simulation models. Time allotted: 1 lecture and 1 tutorial/week.

MA207 Operations Research II: scheduling, several machines, extensions of deterministic inventory models and introduction to stochastic models, queueing theory, travelling salesman problem, applications of linear programming in n dimensions including the transportation problem. Time allotted: 2 lectures and 1 tutorial/week.

MA307 Dynamic Programming: multistage allocation processes, shortest path algorithms, multistage decision processes, application to inventory, replacement and production models, state increment dynamic programming. Time allotted: 2 lectures and 1 tutorial/week.

MN202 Linear Programming: topics include convex sets, simplex method, revised simplex method, duality, dual-simplex algorithm, post-optimality analysis, branch and bound methods for integer programming. Time allotted: 1 lecture and ½ tutorial/week.

MN307 Mathematical Programming: further material from linear programming and an introduction to unconstrained and constrained optimisation of non-linear functions of several variables, covering basic theory and descriptions of some currently used algorithms. Time allotted: 1 lecture and ½ tutorial/week.

MP104 Abstract Algebra I: logic, integers (including examples of recursive definitions and iterative algorithms), rational numbers, sets, relations (illustrated by directed graphs and rooted trees), groups, rings, fields, Boolean algebra, geometry of transformations. Time allotted: 2 lectures and 1 tutorial/week.

MP304 Geometry III: projective and affine geometry of finite and infinite planes, theorems of Desargues and Pappus, co-ordinatisation, ternary rings. Time allotted: 2 lectures and 1 tutorial/week.

MS374 Experimental Design IIIH: experimental design and analysis of variance. Time allotted: 2 lectures and 2 tutorials/week.

MS474 Experimental Design: advanced experimental design and analysis of variance.

II. NEW SOUTH WALES AND AUSTRALIAN CAPITAL TERRITORY

(1) Canberra College of Advanced Education

Applied Graph Theory: topics will include bipartite graphs, planarity, trees, connectivity, shortest paths, optimal flow, Euler tours, Hamiltonian circuits, directed graphs, tournaments and ranking strategies. Time allotted: 3 lectures and a 2-hour tutorial/week. Texts: Bondy and Murty, Andrásfai.

Combinatorial Mathematics (not available in 1980): topics will be chosen from: counting, partitions, Pólya's theorem, coding theory, transversal theory, block designs, efficient computability. Time allotted: 5 hours/week.

Combinatorial Mathematics II (not available after 1980): topics chosen from among: coding theory, algorithms of various kinds, partitions, transversal theory, block designs and associated topics, counting in various ways, lattices, computability and associated topics, combinatorics of finite sets. Time allotted: 3 lectures and 2 tutorials/week. Text: Stone.

Discrete Mathematics: topics will include binomial coefficients, permutations and combinations, pairing problems, generating functions, recurrence relations, inclusion and exclusion. Time allotted: 3 lectures and a 2-hour tutorial/week. Text: Cohen. The use of small groups as a form of instruction and learning is encouraged.

Discrete Mathematics G: topics will be chosen from: enumerative analysis including the principle of inclusion and exclusion; connected and disconnected graphs, trees, tournaments, domination, matching theory and other related graph theoretical concepts; coding theory, scheduling and sorting algorithms, orthogonal Latin squares, block designs and Hadamard matrices. Time allotted: 5 hours/week. Text: Liu.

(2) University of Newcastle

The University of Newcastle has a number of relatively specialised courses in combinatorics and graph theory. The course in topological graph theory is noteworthy in that it is the only undergraduate course in Australia or New Zealand whose syllabus mentions the proof of the four colour theorem. Presumably some details are omitted!

662203 Finite Mathematics: linear programming, theory of games, graph theoretic models, Markov processes, inventory and storage models, queueing theory. Time allotted: 1 lecture/week and 1 tutorial/fortnight. Text: Goodman & Ratti. This course is an option in second year mathematics.

664153 Algebraic Graph Theory: the adjacency matrix of a graph, path lengths, shortest paths in a graph, spectrum of a graph, regular graphs and line graphs, homology of graphs, spanning trees, complexity of a graph, determinant of the adjacency matrix, automorphisms of graphs, vertex transitive graphs, symmetric graphs with attention to the trivalent case, covering graph of a graph, distance-transitive graphs, realisability of intersection arrays, primitivity and imprimitivity, minimal regular graphs of given girth. The course will finish with a selection of topics related to vertex colourings and the chromatic polynomial, as time permits. Time allotted: 27 lectures. Text: Biggs. This course is an option in fourth year mathematics.

664142 Topological Graph Theory: Kuratowski's theorem; genus, thickness, coarseness and crossing numbers of graphs; chromatic number of a surface; proof of the four colour theorem by Appel and Haken. Time allotted: 27 lectures. At most one of 664153 and 664142 will normally be offered each year.

664106 Combinatorics: permutations and combinations, inclusion-exclusion and generating functions, Pólya's theorem and its application to counting various kinds of structures and graphs, asymptotic analysis of many of the exact results. Time allotted: 27 lectures.

664105 Combinatorial Designs: introduction to various types of designs and their properties; pairwise balanced designs: basic theory, some existence theorems, Wilson's theorems; Latin squares and balanced incomplete block designs: the existence theory using pairwise balanced designs and various constructions; partial balance; Room squares; Hadamard matrices; block designs on graphs, such as handcuffed designs. Time allotted: 27 hours. Text: Street & Wallis.

Each of the above courses is assessed by means of a 2-hour examination.

(3) University of New England

The University of New England has three undergraduate courses in combinatorics. "Applied Combinatorics" is a motivational introductory second-year course with an emphasis on applications. "Combinatorial Mathematics" is a more rigorous theoretical third-year course, though still somewhat application-oriented. "Combinatorics IV" is a fourth-year Honours course.

Applied Combinatorics: graph theory, enumeration techniques, block designs. Time allotted: 12 lectures.

Combinatorial Mathematics: block designs and projective planes, orthogonal Latin squares, Galois fields, difference sets, applications of finite planes, Room squares, Boolean algebra from Huntington's axioms, applications of two-valued Boolean algebra. Time allotted: 12 lectures.

Combinatorics IV: a choice of combinatorial number theory, Room squares, finite planes, advanced Boolean algebra, or any other suitable topic.

(4) University of Sydney

(a) Department of Applied Mathematics

Graph Theory and Applications: graphs, multigraphs, pseudographs, digraphs, subgraphs, spanning subgraphs, isomorphism of graphs, degree of a vertex, complete graphs, bipartite graphs, paths and

circuits, connected graphs, connectedness of a digraph, Eulerian graphs, Hamiltonian graphs, trees, forests, counting trees, spanning trees, fundamental circuits, Kirchhoff's laws, Heider's theory of balance and its graph theoretic formalization, matrix representation of graphs, incidence matrix, adjacency matrix, matrix-tree theorem, circuit matrix, path matrix, economic activity analysis (input-output model), transportation networks, flows, capacity of arc, cut-sets, Ford-Fulkerson theorem, applications, extensions including lower bounds on arc flows, transversal theory, matching, Hall-Ore theorem, counting theory, cycle index, Pólya's theorem, counting graphs. Text: Street & Wallis. This course is taught in second year.

(b) Department of Pure Mathematics

The Department of Pure Mathematics offers a second-year course, Discrete Mathematics (P), and two third-year courses, Combinatorial Theory (H) and Combinatorial Theory (P).

Discrete Mathematics (P): basic concepts in the theory of graphs, trees, paths in graphs, matrices associated with a graph, planarity, colouring, transport networks, matching theory, permutations, combinations, generating functions, principle of inclusion and exclusion. Text: Bondy and Murty.

Combinatorial Theory (H): introduction to the theory of t-designs and error-correcting codes, existence and construction of 2-designs, linear codes, cyclic codes, construction of t-designs from linear codes.

Combinatorial Theory (P): combinatorial identities and related enumeration problems; inversion formulae; elementary operational calculus of differential operators and polynomials of binomial type; partially ordered sets: Möbius and zeta functions, Dilworth's theorem and its application to matching theory.

(5) University of Wollongong

MATH231 Finite Mathematics and Combinatorial Analysis. Time allotted: 2 hours/week for one year. Text: Roberts. This is a second-year course.

III. VICTORIA

(1) Deakin University

Deakin has two third-year courses of 15 lectures each.

Combinatorics: recurrence relations, generating functions, matchings, inclusion-exclusion principle. Text: Anderson.

Graph Theory: definitions, Eulerian and Hamiltonian graphs, planarity, colouring. Text: Wilson.

(2) Footscray Institute of Technology

MA371 Graph Theory: definitions, representations, strong components, bases, set-covering problem with applications, graph colouring, trees, algorithms for shortest spanning tree and shortest path between all pairs of vertices, P.E.R.T. and C.P.A. as special cases, Eulerian paths and Chinese postman's problem, Hamiltonian paths and travelling salesman problem, the shortest spanning tree and assignment methods applied to the travelling salesman problem, network flows, basic maximum flow problem and variations thereon. Time allotted: 4 hours/week for 7 weeks. Text: Christofides. Emphasis is placed on algorithms and applications. The course is taught in third year.

In addition, a second-year subject, MA272, contains a small amount of graph theory. The syllabus includes directed and undirected graphs, paths and trees.

(3) Gippsland Institute of Advanced Education

G.I.A.E. has one third-year combinatorics course available to internal and external students.

6366 Combinatorics: principles of enumeration: elementary counting principles, permutations and combinations, generating functions, recurrence relations, principle of inclusion-exclusion; combinatorial structures: block designs, Latin squares, difference sets, directed and undirected graphs, combinatorial matrices; applications: design of experiments, error correcting codes, transportation and allocation problems, applications of graph theory. Time allotted: 4 hours/week during the second semester. Assessment: 40% assignments, 60% 3-hour exam. Text: Anderson. The course usually runs two years out of every three.

(4) La Trobe University

Graphs are used in the analysis of electrical networks as part of Applied Mathematics III.

(5) Melbourne State College

Three courses are taught at the third year level.

Combinatorics and Number Theory: general rules of combinatorics, samples, permutations and combinations, distributions and partitions, occupancy problems, recurrence relations, generating functions, rook polynomials. The remainder of the syllabus consists of number theory topics.

Graph Theory: basic concepts, planar and connected graphs, Euler and Hamilton circuits, isomorphic graphs, automorphism group of a graph, composition of graphs and associated groups, directed graphs and applications.

Network Flow Theory and Applications: survey of the place of network concepts in the solution of practical problems, shortest (longest) path algorithms, critical path analysis, maximum flow in a network with capacity restrictions, minimum cost - maximum flow algorithms (including modern simplified methods of Hu and others), applications including dynamic programming techniques.

Assessment for each of these courses is based on examination and assignments.

[To be continued in *Combinatorics* Vol. 2., No.3.]

APPENDIX

The following is a list of books used as texts in undergraduate courses in combinatorics and graph theory in Australia and New Zealand. They have been referred to above by the author's surname only.

1. Anderson, A First Course in Combinatorial Mathematics, Clarendon, 1974.
2. Andrásfai, Introductory Graph Theory, Hilger, 1977.
3. Anton & Kolman, Applied Finite Mathematics, Academic Press, 1978.
4. Biggs, Algebraic Graph Theory, Cambridge, 1974.
5. Bondy & Murty, Graph Theory with Applications, Macmillan, 1977.
6. Christofides, Graph Theory: An Algorithmic Approach, Academic Press, 1975.
7. Cohen, Basic Techniques of Combinatorial Theory, Wiley, 1978.
8. Deo, Graph Theory With Applications to Engineering and Computer Science, Prentice-Hall, 1974.
9. Goldberg, Introduction to Difference Equations, Wiley, 1958.
10. Goodman & Ratti, Finite Mathematics with Applications (3rd ed.), Macmillan, 1979.
11. Hall, Combinatorial Theory, Wiley, 1967.
12. Knuth, The Art of Computer Programming, Addison-Wesley, 1968.
13. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill, 1968.
14. Ore, Graphs and Their Uses, Singer, 1963.
15. Roberts, Discrete Mathematical Models, Prentice-Hall, 1976.
16. Stone, Discrete Mathematical Structures and their Applications, S.R.A., 1973.
17. Street & Wallis, Combinatorial Theory: An Introduction, Babbage, 1977.
18. Taha, Operations Research, Macmillan, 1976.
19. Wilson, Introduction to Graph Theory, Oliver & Boyd, 1972.

Eighth Australian Conference on Combinatorial Mathematics

Third Notice

The Eighth Australian Conference on Combinatorial Mathematics will be conducted by the Combinatorial Mathematics Society of Australasia at Deakin University, Geelong, Victoria, Australia from Monday, 25 August to Friday, 29 August, 1980. The second Annual General Meeting of the C.M.S.A. will be held at the conference on Wednesday, 27 August, 1980. The Conference will commence with registration at 0900 hours on 25 August, 1980 and finish at about 1300 hours on 29 August, 1980.

All interested persons are cordially invited to attend. If in response to the Second Notice you sent a reply form, a confirmation form is enclosed. If you intend going to the conference and have not yet sent a reply form or sent an incomplete reply or wish to change your reply to an item please complete the attached reply form and send it immediately.

PATRONAGE :

We gratefully acknowledge the generous financial support given or promised to the conference by the following organisations :

Deakin University
Australia and New Zealand Banking Group Limited
Blue Circle Southern Cement Limited
Australian Mathematical Society
National Mutual Life Association of Australasia Ltd.
Trans-Australia Airlines

INVITED ADDRESSES :

Dr. Brian A. Alspach, (Simon Fraser University)
Hamiltonian paths and cycles in vertex-transitive graphs.
Dr. Chuan-Chong Chen, (Nanyang University)
Strongly hamiltonian abelian group-graphs.
Dr. Ronald L. Graham, (Bell Telephone Laboratories)
Long lattice paths in subsets of Z^n.
Prof. Peter J. Lorimer, (University of Auckland)
The construction of finite projective planes.
Prof. Ronald C. Read, (University of Waterloo)
A survey of graph generation techniques.
Prof. Johan J.Seidel, (University of Technology, Eindhoven)
Two-distance sets.
Dr. John Sheehan, (University of Aberdeen)
Finite ramsey numbers.
Prof. Ralph G. Stanton, (University of Manitoba)
Further results on covering computations.

Also, pending finance, Prof. Jun-Shung Hwang (Academia Sinica) *Complete stable marriages and systems of I-M preferences.*

In addition, Ron Graham will give one expository lecture, *Distance matrices of trees*, and Ralph Stanton will give two expository lectures, *Construction of H-systems*, *Computation of number theoretic coverings.*

CONTRIBUTED PAPERS :

So far the following have indicated they will deliver contributed talks of 30 minutes :

A.J. Rahilly, W.D. Wallis, D.G. Rogers, C.H.C. Little, R. Taylor, A. Brace, P. Eades, J-L Lassez, S. Williams, J.E. Dawson, E. Durnberger, K. Heinrich, D.E. Taylor, W. Haebich, L.R. Foulds, R.W. Robinson, J.D. Jarratt, D. Billington, D.A. Holton, H. Tverberg, A. Hartman, D. Street, K.L. McAvaney, C.H. Rowley, R.A. Bailey.

If you want to present a paper on any area of pure or applied combinatorics but your name is not above, please reply on the attached form immediately.

CONFERENCE PROCEEDINGS :

Springer-Verlag have agreed to publish the referred proceedings of the conference in the Lecture Notice is Mathematics series.

Authors are requested to submit their typescript to the undersigned by 30 September, 1980. Special typing instructions will be issued at the conference.

SOCIAL PROGRAMME :

The Conference Dinner will be on Thursday evening 28 August, 1980. This will be a special four course meal and include drinks. There is no extra charge for participants in campus accommodation. The charge for others is $15 per person, payable on registration at the conference.

The Games Night will be on Monday evening 25 August, 1980. Bridge, chess, go, hex, etc. will be provided.

The Excursion will be from 1030 to 1530 on Tuesday, 26 August, 1980 and include a tour of century old Fort Queenscliff and a two course smorgasbord lunch at the equally old Queenscliff Hotel. The cost, including bus, is $8 per person payable on registration.

ACCOMMODATION :

The campus accommodation consists of single bed/study rooms clustered five per toilet/shower room and fifteen per lounge/kitchen. The cost is $25 per day and except for lunch on excursion day includes all meals, including the special Conference Dinner, commencing with tea on Sunday, 24 August, 1980 and finishing with lunch on Friday, 29 August, 1980. If you want to book this accommodation and have not yet done so, please reply on the attached form and send $10 deposit per person (payable to C.M.S.A.) immediately.

The conference venue is the Waurn Ponds Campus of Deakin. (Repondents have a map enclosed.) The sessions will be in The Lecture Theatre. Meals will be in the Union.

REGISTRATION :

Registration fees are payable at the conference and will be $27 for those in full time employment and $12 otherwise. There will be $2 reduction in both cases for members of C.M.S.A.

BOOK DISPLAY :

There will be a display of combinatorics titles from Academic Press, Springer Verlag, etc. in the foyer of the conference lecture theatre.

TRAVEL :

Geelong is approximately 80 km south west of Melbourne. It is planned to use (free) Deakin mini buses to transport participants between Melbourne Airport and Deakin University. To help with the arrangements, participants travelling by air are asked, where possible, to book their flights to arrive at Melbourne Airport before 1700 hours on Sunday, 24 August, 1980 and leave Melbourne Airport after 1600 hours on Friday, 29 August, 1980, and reply on the attached form immediately if they have not yet done so.

K.L. McAVANEY, Director C.M.S.A.
Division of Computing and Mathematics, Deakin University, Victoria 3217.
Australia. Phone (052) 471382. Telex AA35625.

Australia - orientated for northern hemisphere conferees.

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Reply Form

Please circle the appropriate answers. Return this form to K.L. McAvaney, Division of Computing and Mathematics, Deakin University, Victoria 3217, Australia, immediately.

1. I expect to attend: YES / NO

2. I want to present a 30 minute paper: YES / NO

   Title: _____

   _____

   Please attach a typed abstract.

3. I want to attend the Conference Dinner: YES / NO

   Accompanied by _____ non-conferees.

4. I want to attend the Games Night: YES / NO

   Game: _____ Grade: Poor/Fair/Good

5. I want to attend the excursion: YES / NO

6. I want Deakin transport from Melbourne Airport to Deakin University: YES / NO

   Airline: _____ Flight Number _____

   Expected time of arrival in Melbourne _____

7. I want to book the on campus accommodation: YES / NO

   On nights: Sunday 24 August, Monday 25 August 1980, Tuesday 26 August 1980, Wednesday 27 August 1980, Thursday 28 August 1980, and

   _____ .

   Number of persons: _____ .

   I enclose $_____ on campus accommodation deposit (payable to C.M.S.A.).

NAME _____

ADDRESS FOR NOTICES _____

_____

_____

PHONE NUMBER _____