THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

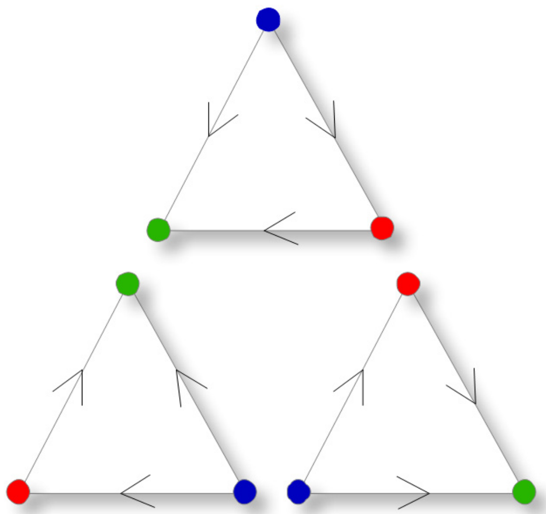
Queen Mary University of London

Queen Mary, University of London

The London School of Economics and Political Science

Two One-Day Colloquia in Combinatorics

14th and 15th May 2014



If attending both days, please keep this programme for day two

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INFORMATION

Those interested are welcome to attend for all or any part of the event; it is hoped that many people will be able to attend for both days.

Some funds are available to contribute to the **basic** travel expenses of **research students** who attend the meetings. We ask you to keep costs to a minimum, using public transport on **all** occasions and off-peak student travel tariffs wherever possible. Receipts for all journeys must be maintained as proof of travel. At this stage, we are unable to confirm the maximum amount available. Expense claim forms are available at the event from the event organisers. Please contact Rebecca Lumb (r.c.lumb@lse.ac.uk) for further information.

Event organisers: Dr Robert Johnson (QMUL) and Dr Jozef Skokan (LSE).

SUPPORT

Support for this event from the London Mathematical Society (www.lms.ac.uk) and the British Combinatorial Committee (www.maths.qmul.ac.uk/~pjc/bcc) is gratefully acknowledged.

British Combinatorial Committee

LONDON MATHEMATICAL SOCIETY

WEDNESDAY 14th MAY 2014
Schedule

The first day of the Colloquia in Combinatorics will be held at Queen Mary, University of London on Wednesday 14th May, starting at 10.30am. Everyone interested is welcome to attend any part of the event. All the talks will be held in the Maths Lecture Theatre, Mathematical Sciences Building, Mile End Campus, QMUL.

Time	**Speaker**	**Presentation title**
10:00	**Coffee** *(Maths Building Foyer)*	
10:30	Peter Keevash (Oxford)	The existence of designs
11:20	Vytautas Gruslys (Cambridge)	Orientations of hypergraphs and sparse Ramsey theory
12:10	**Lunch** *(own arrangements – options on campus and nearby)*	
13:30	Ben Barber (Birmingham)	Partition regularity and the columns property
14:20	Ehud Friedgut (Weizmann Institute)	Combinatorial problems in the symmetric group, stability and quasi-stability
15:10	**Afternoon tea break** *(Maths Building Foyer)*	
15:40	Konrad Swanepoel (LSE)	Counting double-normal pairs in Euclidean space
16:30	Miklós Simonovits (Hungarian Academy of Sciences)	Stability methods, supersaturated graphs, phase transitions
17:20	**End**	

The existence of designs

Peter Keevash

A Steiner Triple System on a set X is a collection T of 3-element subsets of X such that every pair of elements of X is contained in exactly one of the triples in T. An example considered by Plücker in 1835 is the affine plane of order three, which consists of 12 triples on a set of 9 points. Plücker observed that a necessary condition for the existence of a Steiner Triple System on a set with n elements is that n be congruent to 1 or 3 mod 6. In 1846, Kirkman showed that this necessary condition is also sufficient. In 1853, Steiner posed the natural generalisation of the question: given q and r, for which n is it possible to choose a collection Q of q-element subsets of an n-element set X such that any r elements of X are contained in exactly one of the sets in Q ? There are some natural necessary divisibility conditions generalising the necessary conditions for Steiner Triple Systems. The Existence Conjecture states that for all but finitely many n these divisibility conditions are also sufficient for the existence of general Steiner systems (and more generally designs). We prove the Existence Conjecture, and more generally, we show that the natural divisibility conditions are sufficient for clique decompositions of simplicial complexes that satisfy a certain pseudorandomness condition.

Orientations of hypergraphs and sparse Ramsey theory

Vytautas Gruslys

Let G be an r-uniform hypergraph. When is it possible to orient the edges of G in such a way that every p-set of vertices has some p-degree equal to 0? (The p-degrees generalise for sets of vertices what in-degree and out-degree are for single vertices in directed graphs.) Caro and Hansberg asked if the obvious Hall-type necessary condition is also sufficient.

Our main aim is to show that this is true for r large (for given p), but false in general. Our counterexample is based on a new technique in sparse Ramsey theory that may be of independent interest.

Partition regularity and the columns property

Ben Barber

A system of linear equations with integer coefficients is partition regular if, whenever the natural numbers are finitely coloured, it has a monochromatic solution. In 1933 Rado showed that a finite system of equations is partition regular if and only if its matrix of coefficients has the "columns property".

It is easy to write down infinite systems which have the columns property but are not partition regular. However, all known examples of infinite partition regular systems do have the columns property. Must all infinite partition regular systems have the columns property ?

Combinatorial problems in the symmetric group, stability and quasi-stability

Ehud Friedgut

Many problems in extremal combinatorics exhibit a "stability" phenomenon: solutions that are close to achieving the extremum, must also be close in structure to the true extremal examples (e.g. the extremal solutions in the Erdős-Ko-Rado theorem, or isoperimetric extrema in the Boolean cube).

In this talk I will present some combinatorial problems set in the symmetric group for which such a stability phenomenon exists, but also other problems where one can construct near-extremal examples by taking a union of truly extremal sets, what we coin as quasi-stability.

Pleasingly enough, this is mirrored (or rather, encoded) by algebraic phenomena which arise naturally when one attempts to solve these problems using representation theoretic tools, as we do.

I will attempt to describe these phenomena, but will avoid diving too deeply into representation theory, as there is a nice translation of the above into a simpler language.

This is joint work with David Ellis, Yuval Filmus, and Haran Pilpel.

Counting double-normal pairs in Euclidean space

Konrad Swanepoel

Given a set of n points in Euclidean space, there are various ways of declaring two points to be "far apart". Two well-known notions are *diameter pairs*, where the distance between the points equals the diameter of the set, and *antipodal pairs*, where there are parallel hyperplanes through the two points such that the whole set is contained in the closed slab bounded by the hyperplanes. Martini and Soltan (2006) introduced the notion of a *double-normal pair* of points, where we ask in addition to antipodality that the parallel hyperplanes are perpendicular to the line joining the two points. This very natural notion lies between that of diameter pair and antipodal pair.

We survey the problems of determining the maximum number of diameters, antipodal pairs, or double-normal pairs in a set of n points in Euclidean space. While the problem for diameters is well understood, and the problem for antipodal pairs seemingly difficult, it seems that nothing has been done before for double-normal pairs. We present asymptotically exact results in dimension 3 and some partial results in higher dimensions.

This is joint work with János Pach (Lausanne and Budapest).

Stability methods, supersaturated graphs, phase transitions

Miklós Simonovits

In the lecture I will concentrate on three strongly connected problems: Stability phenomena in extremal graph theory, supersaturated graphs and phase transitions.

The stability means that we have a family of forbidden graphs (hypergraphs) and consider graphs not containing some forbidden subgraphs, increasing the edge-number slowly, and as soon as we almost reach the maximum (extremum), the struchtures of the considered graphs become very similar. Next we go above the maximum and suddenly very many forbidden graphs emerge in the considered graphs: this is the phase transition.

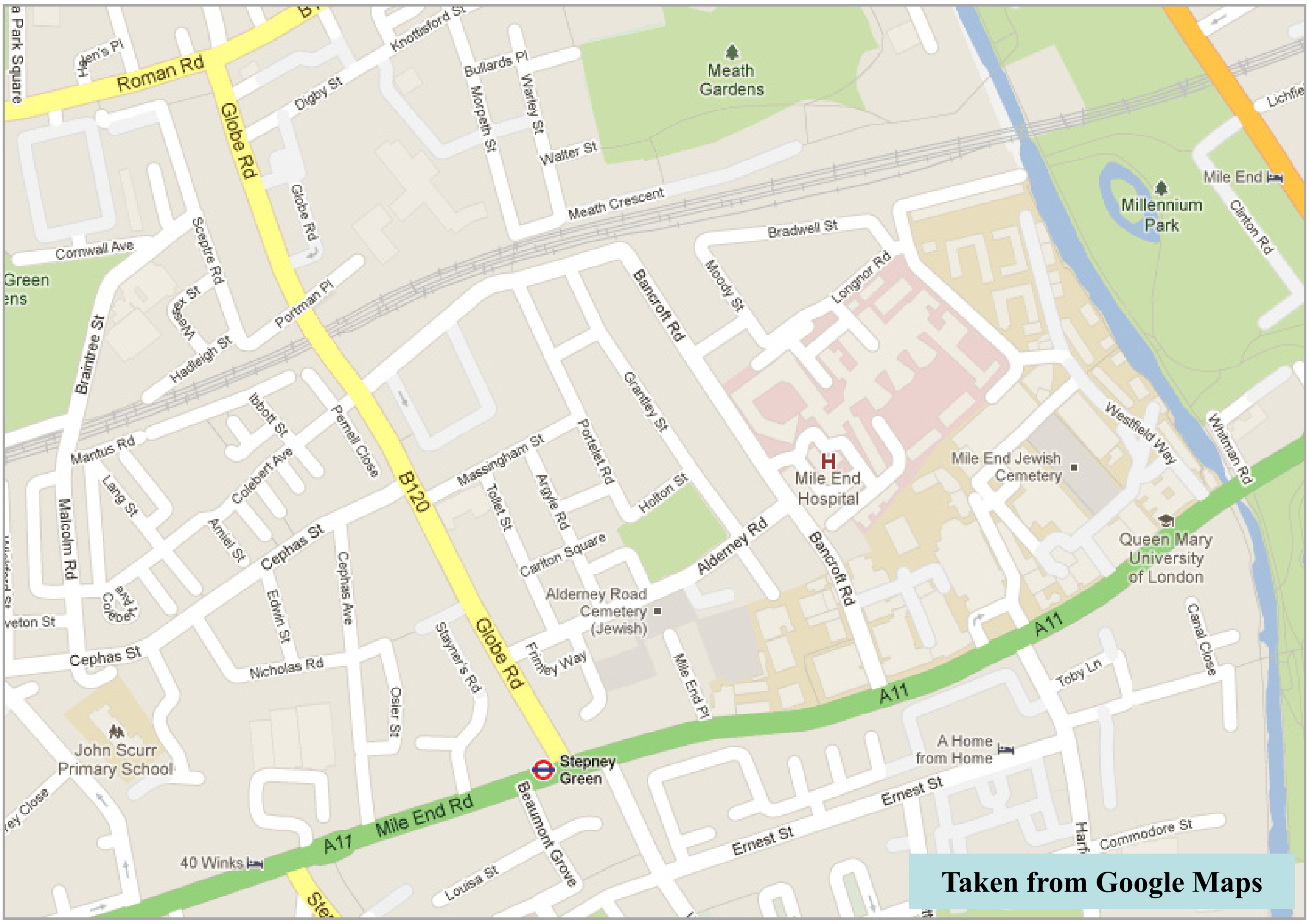
Such questions can be considered in several settings: graph problems, digraph problems, hypergraph problems, Ramsey-Turán type problems.

We can increase the number of edges and obtain this way fairly complicated problems.

We shall consider related phenomena and also several related open questions.

PLACES TO EAT: in and around QMUL

Drapers Bar and Kitchen – wide range to suit all dietary requirements, Bancroft Road
Drunken Monkey – Asian fusion, Westfield Way
Greedy Cow – gastropub food, Grove Road
Half Moon Pub – Wetherspoons serving standard pub food, Mile End Road
Matsu – Japanese food, Mile End Road
Morgan Arms – Up-market pub food, Morgan Street
Mucci's – Italian trattoria, Library Square
Nandos – Portuguese Chicken, Mile End Road
Pride of Asia – Bangladeshi restaurant with all-you-can-eat buffet, Mile End Road
The Curve – international food to eat-in or take away, Westfield Way
The Jasmine Kitchen – railway arch café serving Thai food, White Church Lane



Taken from Google Maps

Mile End Campus Map

Educational/Research

ArtsOne	37
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(i) Information

Visitors who require further information or assistance please go to the Main Reception in the Queens' Building.

Please do not smoke on the campus.

These premises are alarmed and monitored by CCTV, please call Security on 020 7882 5000 for more information.

- Library/bookshop
- Fitness centre
- Bar
- Coffee place
- Eatery
- (P) Staff car park
- Bicycle parking
- (BL) Bicycle lockers
- (£) Cash machine

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

THURSDAY 15th MAY 2014
Schedule

The second day of the Colloquia in Combinatorics will be held at The London School of Economics and Political Science on Thursday 15th May, starting at 10.00am. Everyone interested is welcome to attend any part of the event. The talks will be held in the New Theatre (room number: EAS.E171), East Building, LSE; refreshments breaks will be taken in EAS.E168, East Building, LSE; reception will be held in the Senior Common Room, Fifth Floor Old Building, LSE.

Time	Speaker	Presentation title
10:00	Paul Wollan (Rome)	When are directed graphs well-quasi-ordered under taking minors
10:50	**Coffee break** *(room EAS.E168)*	
11:20	Penny Haxell (Waterloo)	Extremal graphs for connectedness
12:10	Pavel Valtr (Prague)	Happy ending theorem and some related questions and results
13:00	**Lunch** *(own arrangements – options on campus and nearby)*	
14:20	József Balogh (Szeged and UIUC)	On the typical structure of sum-free sets
15:10	**Afternoon tea break** *(room EAS.E168)*	
15:40	Diana Piguet (Birmingham)	An approximate version of the tree packing conjecture for bounded degree graphs
16:30	Peter Cameron (St. Andrews)	**THE NORMAN BIGGS LECTURE:** Combinatorial problems from transformation semigroups
17:30	**Reception** *(Senior Common Room, Fifth Floor Old Building)*	

When are directed graphs well-quasi-ordered under taking minors

Paul Wollan

A containment relation $\preceq$ on graphs is a *well-quasi-order* if for every infinite sequence of graphs $G_1, G_2, G_3, \ldots$ there exists indices i, j, $i < j$, such that $G_i \preceq G_j$. Many natural models of graph containment such as subgraph or topological minor are not well-quasi-orders, and it is easy to construct infinite antichains of graphs which show this. Wagner conjectured, however, that graphs are well quasi-ordered under graph minors and this was confirmed by Robertson and Seymour in their famous Graph Minors series of papers.

If we consider directed graphs, there is a natural example of an infinite antichain of graphs under containment as a *directed minor*, implying that directed graphs are not well-quasi-ordered under directed minors. In this talk, we will discuss recent work which shows that this antichain is in a certain sense unique, and if a subset of digraphs avoids the antichain, then it is well-quasi ordered under directed minors. The end result is an exact characterization of directed minor ideals which are well-quasi-ordered under directed minors.

Extremal graphs for connectedness

Penny Haxell

It is known that the topological connectedness of the independence complex of a line graph $L(G)$ is bounded below by $\nu(G)/2 - 2$, where $\nu(G)$ denotes the matching number of G. This graph parameter turns out to be important in the study of hypergraph matchings. We classify the bipartite graphs G for which this parameter attains the value $\nu(G)/2-2$, and describe the consequences of our work for some long-standing conjectures about hypergraphs.

This is joint work with Lothar Narins and Tibor Szabó.

Happy ending theorem and some related questions and results

Pavel Valtr

The Erdős–Szekeres k-gon theorem (1935), sometimes called Happy ending theorem, says that for any integer $k \geq 3$ there is an integer $n(k)$ such that any set of $n(k)$ points in the plane, no three on a line, contains k points which are vertices of a convex k-gon. It is a classical result both in combinatorial geometry and in Ramsey theory.

We shall discuss various results and open problems related to the Erdős–Szekeres theorem. For example, it is still widely open if the minimum possible value of $n(k)$ is equal to $2^{k-2} + 1$, as conjectured by Erdős and Szekeres more than fifty years ago. Some recent results related to the Erdős–Szekeres theorem are purely combinatorial, dealing with colored (hyper)graphs on linearly ordered vertex sets.

On the typical structure of sum-free sets

József Balogh

First we study sum-free subsets of the set $\{1, \ldots, n\}$, that is, subsets of the first n positive integers which contain no solution to the equation $x+y=z$. Cameron and Erdős conjectured in 1990 that the number of such sets is $O(2^{n/2})$. This conjecture was confirmed by Green and, independently, by Sapozhenko. We prove a refined version of their theorem, by showing that the number of sum-free subsets of $[n]$ of size m is $2^{O(n/m)}\binom{\lceil n/2 \rceil}{m}$, for every $1 \leq m \leq \lceil n/2 \rceil$. For $m \geq \sqrt{n}$, this result is sharp up to the constant implicit in the $O(\cdot)$. Our proof uses a general bound on the number of independent sets of size m in 3-uniform hypergraphs, proved recently by the authors, and new bounds on the number of integer partitions with small sumset.

Then we study sum-free sets of order m in finite Abelian groups. We determine the typical structure and asymptotic number of sum-free sets of order m in Abelian groups G whose order n is divisible by a prime q with $q \equiv 2 \pmod 3$, for every $m \geq C(q)\sqrt{n \log n}$, thus extending and refining a theorem of Green and Ruzsa. In particular, we prove that almost all sum-free subsets of size m are contained in a maximum-size sum-free subset of G.

Finally, we explain connection with recent "independent sets in hypergraph" general theorems, and describing typical structure of graphs.

In the talk I try to have different approach from other talks on "independent sets in hypergraph" general theorems

The talk is based on joint results with Noga Alon, Rob Morris, Wojciech Samotij and Lutz Warnke.

An approximate version of the tree packing conjecture for bounded degree graphs

Diana Piguet

A family of graphs packs into a graph G if there exist pairwise edge-disjoint copies of its members in G. We prove a theorem about packing trees into a complete graph. The result implies asymptotic versions of the Tree Packing Conjecture of Gyárfás and the Ringel Conjecture for the class of trees with bounded maximal degree. The core of the proof is a random process controlled by the nibbling method.

This is joint work with Julia Böttcher, Jan Hladký, and Anusch Taraz.

“The Norman Biggs Lecture”

Combinatorial problems from transformation semigroups

Peter Cameron

The study of finite transformation semigroups leads to many problems in combinatorics and permutation groups which have not been very much considered. The problems resemble design theory, but rather than concerning subsets of a finite set of two cardinalities, they tend to involve subsets and partitions of the same cardinality. The key fact is that if two transformations have the same rank, then their product also has the same rank if and only if the image of the first is a transversal for the kernel of the second. We are led to consider such problems as: what are the largest (in a suitable sense) sets of subsets and partitions so that no subset is a transversal for any of the partitions ? What is the smallest set of subsets which contains a transversal for every partition ? Which permutation groups have the property that some orbit on subsets contains a transversal for every partition ? I will survey some results and open problems, and some consequences for semigroup theory.

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

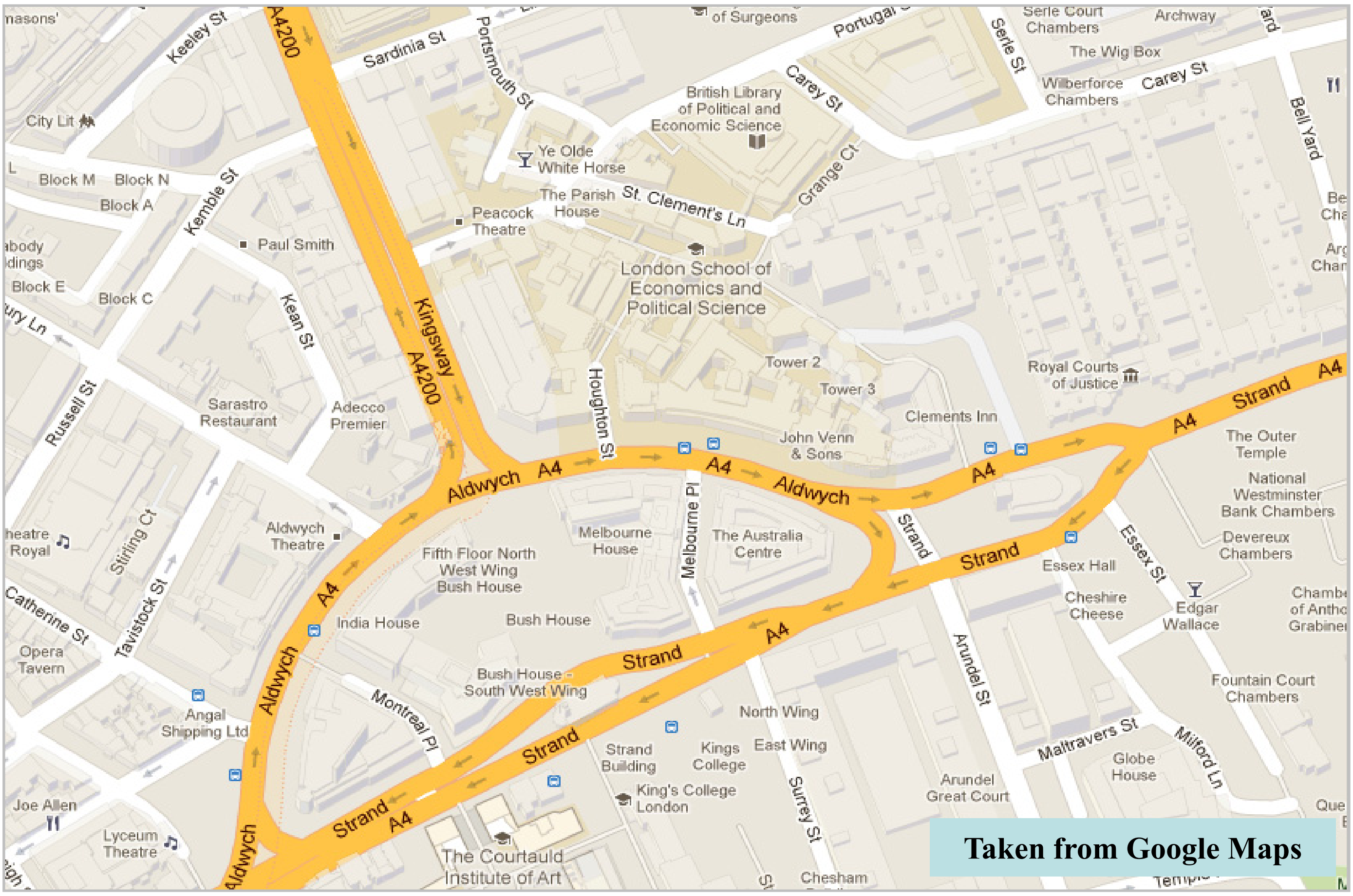
PLACES TO EAT: in and around LSE

Close by:

All Bar One - Kingsway
Belgo - Kingsway
Café Amici - Kingsway
Café Nero - Kingsway
Costa - Kingsway
EAT - Kingsway
Hot - Kingsway
Paul - Kingsway
Pret a Manger - Kingsway
Sainsburys - Kingsway
Starbucks - Kingsway
Subway - Kingsway
The Delaunay - Aldwych
Wasabi - Kingsway

On campus:

Café 54 - Mezzanine floor, New Academic Building
Daily Grind coffee shop - Tower One reception
Fourth Floor Café Bar - Old Building
Fourth Floor Restaurant - Old Building
George IV pub - Portugal Street
LSE Garrick - Ground floor, Columbia House
Plaza Café - John Watkins Plaza
Three Tuns Bar - Ground floor, East Building



Taken from Google Maps

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Disabled access information

- Disabled lift
- Disabled parking
- Toilets for wheelchair user
- Lift
- Unisex toilets
- disabled access

Student Services Centre
Ground floor, Old Building

Graham Wallas Room
OLD 5.25, Old Building

Hong Kong Theatre
Ground floor, Clement House

New Theatre EAS E171, East Building

Old Theatre
Ground floor, Old Building

Shaw Library Sixth floor, Old Building

Sheikh Zayed Theatre
New Academic Building

Thai Theatre New Academic Building

The Wolfson Theatre
New Academic Building

Vera Anstey Room
Between ground and first floor, Old Building

3 Tuns
Ground floor, Clare Market St

Café 54
Ground floor, New Academic Building

Daily Grind Tower 1/2 Reception

Fourth Floor Café Bar Old Building

Fourth Floor Restaurant
Old Building

George IV pub Between LCH and KGS, Portugal Street

LSE Garrick Ground floor, Columbia House

Mezzanine Café New Academic Building

Plaza Café John Watkins Plaza

Senior Common Room and Dining Room Fifth floor, Old Building

Student Common Room
Ground floor, King's Chambers

Disabled access

Portable ramp for 20 Kingsway (**KSW** only) is located in entrance foyer. Please call 020 7955 6200 for Security staff to set up the ramp on request.

After 6.30pm, please call Security Control on 020 7955 6200 to ensure that any disabled access doors are open.

ALD	**Aldwych House** *Aldwych*
ANC	**The Anchorage**
CMK	**Clare Market** *Houghton Street*
CKM	**Clement House** *Aldwych*
COL	**Columbia House** *Aldwych*
CON	**Connaught House** *Aldwych*
COW	**Cowdray House** *Portugal Street*
EAS	**East Building** *Houghton Street*
KGS	**King's Chambers** *Portugal Street*
KSW	**20 Kingsway**
50L	**50 Lincoln's Inn Fields** *Portsmouth Street*
32L	**32 Lincoln's Inn Fields**
LCH	**Lincoln Chambers** *Portsmouth Street*
LAK	**Lakatos Building** *Portugal Street*
LRB	**Lionel Robbins Building, Library** and **LSE Research Lab**
NAB	**New Academic Building** *Lincoln's Inn Fields*
NSC	**New Students' Centre Development** *Sheffield Street*
OLD	**Old Building** *Houghton Street*
PAR	**Parish Hall** *Sheffield Street*
PEA	**Peacock Theatre** *Portugal Street*
POR	**1 Portsmouth Street**
SAR	**Sardinia House** *Sardinia Street*
SHF	**Sheffield Street**
STC	**St Clement's** *Clare Market*
TW1	**Tower One** *Clement's Inn*
TW2	**Tower Two** *Clement's Inn*
TW3	**Tower Three** *Clement's Inn*

January 2013