האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

Discrete Geometry 1 - 80628

Last update 02-09-2021

HU Credits: *6*

Degree/Cycle: *2nd degree (Master)*

Responsible Department: *Mathematics*

Academic year: *0*

Semester: *1st Semester*

Teaching Languages: *English*

Campus: *E. Safra*

Course/Module Coordinator: *Eran Nevo*

Coordinator Email: *nevo.eran@gmail.com*

Coordinator Office Hours: *By appointment*

Teaching Staff:

Prof Eran Nevo

Course/Module description:

The course focuses on basic notions and techniques in the field of Discrete Geometry, regarding point configurations and polytopes.
The techniques include algebraic, topological, geometric and combinatorial methods.
Details on the selected topics appear below.

Course/Module aims:

Learning outcomes - On successful completion of this module, students should be able to:

Students will know fundamental results in Discrete Geometry and be able use algebraic, topological, geometric and combinatorial methods to address problems in the field.

Attendance requirements(%):

The course will include also short student presentations.

Teaching arrangement and method of instruction: Short pre-recorded lectures; live online discussions on the recorded material; short student presentations.

Course/Module Content:

- *Radon's lemma, Helly's theorem, centerpoints, colorful Caratheodory theorem*
- *Euler's formula, crossing numbers, ampli cation through probabilistic method, Szemeredi-*
Trotter theorem, applications to sum-product estimates
- *Unit distances problem, distinct distances, Erdos-Szekeres theorem via hypergraph Ramsey*
theory
- *Number of joints via polynomial method*
- *Polytopes and polyhedra, Minkowski-Weyl theorem, Steinitz' theorem*
- *Balinksi's theorem, Hirsch conjecture, vertex-decomposibility*
- *Gale duality, non-rational polytopes, oriented matroids and their realizability*
- *Neighborly, cyclic, stacked polytopes, f-vectors, Dehn-Sommerville relations, shellability,*
upper bound theorem
- *Triangulations, Voronoi and Delaunay, the associahedron.*

Other or additional topics may be studied

Required Reading:
** J. Matousek. Lectures on discrete geometry. Vol. 212. Springer Science & Business Media, 2013.*
** G.M. Ziegler. Lectures on polytopes. Vol. 152. Springer Science & Business Media, 2012.*

Additional Reading Material:
-- N. Alon and J. Spencer. The probabilistic method. John Wiley & Sons, 2016.
-- R. Graham, B. Rothschild, and J. Spencer. Ramsey theory. Wiley Series in Discrete Mathematics
and Optimization Vol. 20, John Wiley & Sons, 1990.
-- L. Guth. Polynomial methods in combinatorics. University Lecture Series, Vol. 64, American Math-
ematical Society, 2016.

Course/Module evaluation:
End of year written/oral examination 100 %
Presentation 0 %
Participation in Tutorials 0 %
Project work 0 %
Assignments 0 %
Reports 0 %
Research project 0 %
Quizzes 0 %
Other 0 %

Additional information:
Joint course with Berlin Free University (FUB). Lecturers: Christian Haase (FUB), Florian Frick (FUB and Carnegie Mellon University), Eran Nevo (HUJI).