

## The Department of Mathematics

2017–18–B term

**Course Name** Discrete Geometry

**Course Number** 201.2.0191

**Course web page**

<https://www.math.bgu.ac.il/en/teaching/spring2018/courses/discrete-geometry>

**Lecturer** Prof. Shakhar Smorodinsky, <shakhar@bgu.ac.il>, Office 208

**Office Hours** <https://www.math.bgu.ac.il/en/teaching/hours>

### Abstract

### Requirements and grading<sup>1</sup>

The course is intended for 3rd year undergraduate as well as M.Sc and Ph.D. students both in computer science and mathematics. We will touch main topics in the area of discrete geometry. Some of the topics are motivated by the analysis of algorithms in computational geometry, wireless and sensor networks. Some other beautiful and elegant tools are proved to be powerful in seemingly non-related areas such as additive number theory or hard Erdos problems. The course does not require any special background except for basic linear algebra, and a little of probability and combinatorics. During the course many open research problems will be presented.

### Detailed Syllabus:

- Fundamental theorems and basic definitions: Convex sets, convex combinations, separation, Helly's theorem, fractional Helly, Radon's theorem, Caratheodory's theorem, centerpoint theorem. Tverberg's theorem. Planar graphs. Koebe's Theorem. A geometric proof of the Lipton-Tarjan separator theorem for planar graphs.

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<sup>1</sup>Information may change during the first two weeks of the term. Please consult the webpage for updates



- Geometric graphs: the crossing lemma. Application of crossing lemma to Erdos problems: Incidences between points and lines and points and unit circles. Repeated distance problem, distinct distances problem. Selection lemmas for points inside discs, points inside simplexes. Counting k-sets. An application of incidences to additive number theory.
- Coloring and hitting problems for geometric hypergraphs : VC-dimension, Transversals and Epsilon-nets. Weak eps-nets for convex sets. Conflict-free colorings .
- Arrangements : Davenport Schinzel sequences and sub structures in arrangements. Geometric permutations.
- Geometric Ramsey and Turan type theorems: Application of Dilworth theorem, Erdos-Szekeres theorem for convex sets, quasi-planar graphs.

מקבלות צבע שונה?

בכמה אופנים ניתן לחצות 2 נקודות במישור ע"י ישר?

מהו גרף "כמעט מישורי"?

קורס בחירה:

## "גאומטריה קומבינטורית"

201.2.0191

מרצה : פרופסור שחר סמורודינסקי

בסמסטר ב' תשע"ח באוניברסיטת בן-גוריון  
פתוח לתלמידי שנה ג' ומעלה (באישור המרצה)  
ולתלמידי מוסמך

The course is intended for 3<sup>rd</sup> year undergraduate as well as M.Sc students both in computer science and mathematics. We will touch main topics in the area of discrete geometry. Some of the topics are motivated by the analysis of algorithms in computational geometry, wireless and sensor networks. Some other beautiful and elegant tools are proved to be powerful in seemingly non-related areas such as additive number theory or hard Erdos problems. The course does not require any special background except for **basic** linear algebra, and basic probability and combinatorics.

Topics that will be covered include:

- Fundamental theorems and basic definitions (convexity, Helly's thm, Radon's thm, Caratheodory thm, etc)
- Geometric graphs
- Coloring and hitting problems for geometric hypergraphs
- Arrangements : Davenport Schinzel sequences and sub structures in arrangements.
- Geometric Ramsey and Turan type theorems

לפרטים נוספים ניתן ליצור קשר עם המרצה בטל : 08-6461604 או בדואר

אלקטרוני : [shakhar@math.bgu.ac.il](mailto:shakhar@math.bgu.ac.il)



## Course topics

- Fundamental theorems and basic definitions: Convex sets, separation, Helly's theorem, fractional Helly, Radon's theorem, Caratheodory's theorem, centerpoint theorem. Tverberg's theorem. Planar graphs. Koebe's Theorem.
- Geometric graphs: the crossing lemma. Application of crossing lemma to Erdos problems: Geometric Incidences, Repeated distance problem, distinct distances problem. Selection lemmas. Counting  $k$ -sets. An application of incidences to additive number theory.
- Coloring and hitting problems for geometric hypergraphs :  $VC$ -dimension, Transversals and Epsilon-nets. Weak eps-nets for convex sets.  $(p, q)$ -Theorem, Conflict-free colorings.
- Arrangements : Davenport Schinzel sequences and sub structures in arrangements.
- Geometric Ramsey and Turan type theorems: Application of Dilworth theorem, Erdos-Szekeres theorem for convex sets, quasi-planar graphs.