אוניברסיטת בן-גוריון בנגב

המחלקה למתמטיקה

סמסטר ב—2018—19

שם הקורס גיאומטריה אלגברית - סכמות - 2

מספר קורס 201.2.2121

עמוד הקורס ברשת
https://www.math.bgu.ac.il/~amyekut//teaching/2018-19/schemes-2/course_page.html

מרצה אחראי פרופ׳ אמנון יקותיאלי, <amyekut@bgu.ac.il>, חדר 202

שעות קבלה https://math.bgu.ac.il/he/hours

תקציר

דרישות והרכב ציון הקורס[1]

[1] דרישות הקורס יכולות להשתנות במהלך השבועיים הראשונים של הסמסטר, ויש לשים לב להודעות באתר הקורס

Prof. Amnon Yekutieli
Department of Mathematics
Ben Gurion University
Be'er Sheva 84105, ISRAEL
Email: amyekut@math.bgu.ac.il
Web: https://www.math.bgu.ac.il/~amyekut

פרופ' אמנון יקותיאלי
המחלקה למתמטיקה
אוניברסיטת בן גוריון
באר שבע 84105

6 February 2019

Algebraic Geometry – Schemes 2

BGU, Spring 2018-19

General description. The course will attempt to cover most of the material listed in the Topics below, which is similar to the content of Chapters II-III of Hartshorne's book. However, I will not follow any of the existing textbooks, but rather proceed in a fashion that I find more appropriate.

Level. The course is intended primarily for math graduate students at BGU. The lecturing style is going to be quite rapid, with much of the technical material left to homework: reading and writing assignments. (This is going to be very different from the style of the course Schemes 1 in the first semester.)

Prerequisites. Participants of the course should have good familiarity with most of this material: classical algebraic geometry (varieties over an algebraically closed field), commutative algebra, homological algebra, algebraic topology, differentiable manifolds, and the material from the course Schemes 1 (see item 1 in the Topics). I recommend looking at items 1-3 of the Bibliography.

Audience and Registration. Participants from within BGU (graduate students, faculty and advanced undergraduate students), and from outside of BGU, are welcome. The lectures will be in English. Registration is not compulsory, but interested people should **send me an email in advance**, to notify me and get permission to participate (please state your academic status). There will be weekly homework assignments, that all participants are urged (but not required) to solve. Those who will register to the course (catalog number 201.2.2121) will get a pass/fail grade. Passing requires attending all the lectures and submitting most of the HW solutions.

Time and location. The lectures will be on **Wednesdays at 12:00 - 14:00** (2 hours a week), in room 58-201 (Math Building room 201) of the BGU campus. First Meeting: 27 February 2019.

Tutorials. Depending on demand, there might be weekly tutorial sessions, led by post-docs who are experts in algebraic geometry.

Course web page (with updated information):

https://www.math.bgu.ac.il/~amyekut/teaching/2018-19/schemes-2/course_page.html

Course Topics: (Tentative list, probably not realistic.)

1. **Quick review of "Schemes 1".** Sheaves on topological spaces (morphisms of sheaves, sheafification, gluing, inverse and direct images of sheaves), ringed spaces, vector bundles and locally free sheaves, nonabelian 1st Čech cohomology, locally ringed spaces.
2. **Affine Schemes**. Definitions and basic properties. Morphisms. Examples (classical and arithmetic). Finiteness properties.
3. **Schemes**. Definitions and basic properties. Closed and open subschemes. Important types of schemes: noetherian, quasi-compact, reduced, irreducible, connected, regular, etc.
4. **Maps of schemes**. Fiber products and base change. Various kinds of scheme maps: locally finite type, quasi-compact, quasi-separated, affine, finite, flat, separated, proper and projective. Valuative criteria.
5. **Sheaves of modules**. Coherent and quasi-coherent sheaves. Behavior w.r.t. maps of schemes. Descent for sheaves and schemes.
6. **Maps to projective space and blow-ups.** Definitions and examples. Computing the Picard group of the projective space $\mathbf{P}^n$.
7. **Sheaf cohomology.** Čech and derived functor cohomologies. Calculating some invariants (Picard groups, genus, etc.)
8. **Algebraic differential calculus**. Smooth and étale maps, differential forms, etc.
9. **The functor of points and moduli spaces**. Examples. Quick tour of stacks and derived algebraic geometry.
10. **Group schemes and their Lie algebras**. TBA.

Bibliography:

1. Notes from the course Commutative Algebra (2017-18): https://www.math.bgu.ac.il/~amyekut/teaching/2017-18/comm-alg/course_page.html
2. Notes from the course Homological Algebra (2017-18): https://www.math.bgu.ac.il/~amyekut/teaching/2017-18/hom-alg/course_page.html
3. Notes from the course Schemes 1 (Fall 2018-19): https://www.math.bgu.ac.il/~amyekut/teaching/2018-19/schemes-1/course_page.html
4. Hartshorne, *Algebraic Geometry*, Springer.
5. Eisenbud and Harris, *The Geometry of Schemes*, Springer.
6. Olsson, *Algebraic Spaces and Stacks,* AMS.
7. Kashiwara and Schapira, *Sheaves on Manifolds*, Springer.
8. de Jong (Ed.), *The Stacks Project,* online
9. Course lecture notes (to be posted weekly).

אוניברסיטת
בן-גוריון בנגב

נושאי לימוד

1. אלומות (sheaves) על מרחבים טופולוגיים.
2. סכמות אפיניות (affine schemes).
3. סכמות ומורפיזמים ביניהן.
4. אלומות קוואזי-קוהרנטיות.
5. מורפיזמים מופרדים (separated) ומורפיזמים נאותים (proper).
6. אגדים וקטוריים (vector bundles) וחבורת פיקאר (Picard) של סכמה.
7. פונקטור הנקודות (functor of points) ומרחבי מודולים (moduli spaces).
8. מורפיזמים למרחב הפרוייקטיבי ופיצוצים (blow-ups).
9. מורפיזמים חלקים (smooth morphisms) ותבניות דיפרנציאליות (dffierential forms).
10. קוהומולוגיה של אלומות (sheaf cohomology).
11. סכמות חבורה (group schemes).