Course Change Request

New Course Proposal

Date Submitted: 03/02/26 11:38 am

Viewing: **MATH 720 : Algebraic Combinatorics**

Last edit: 03/02/26 11:38 am

Changes proposed by: esander

Are you completing this form on someone else's behalf?

No

Effective Term:	Fall 2026

Subject Code:	MATH - Mathematics	**Course Number:**	720

Bundled Courses:

Is this course replacing another course?   No

Equivalent Courses:

Catalog Title: Algebraic Combinatorics

Banner Title: Algebraic Combinatorics

Will section titles vary by semester?   No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable: May be only taken once for credit, limited to 3 attempts (N3)

Max Allowable Credits: 3

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s):

MATH – 325, Discrete Mathematics II, or equivalent.

In Workflow

1. **MATH Chair**
2. SC Curriculum Committee
3. SC Assistant Dean
4. Assoc Provost-Graduate
5. Registrar-Courses
6. Banner

**Recommended
Corequisite(s):**

**Required
Prerequisite(s) /
Corequisite(s)
(Updates only):**

MATH – 621, Algebra (First year graduate course), or equivalent.

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

**Registration
Restrictions
(Updates only):**

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

**Catalog
Description:**

This course will serve as an introduction to the application of commutative algebra in combinatorics and as a possible bridge between these two hitherto independent topics; commutative algebra (including rings, modules and fields) and combinatorics (including graph theory, enumeration and discrete geometry). We will use abstract algebra and some algebraic topology as important tools to tackle and solve some combinatorial problems. Since the fundamental purpose will be to obtain combinatorial results, the course is called "algebraic combinatorics", but it might as well be called "commutative algebra in combinatorics if one prefers to put more weight on the algebraic tools themselves, instead of the final combinatorial interpretation. – It will be demonstrated that algebraic techniques are powerful and indispensable in numerous combinatorial investigations.

Justification:

This course will strengthen the PhD and MS offerings for students who are focusing on commutative algebra and combinatorics. It has been offered as a special topics course in the past and has been well received with good enrollment.

Does this course cover material which
crosses into another department?   No

Learning Outcomes:

It is expected that after this course it should be clear that a firm knowledge in commutative algebra is
necessary for the working combinatorist, just as it is for many other branches of mathematics like functional
analysis and algebraic topology. Finally, we hopefully will have covered enough topics in algebra and
combinatorial applications for the attenders to be able to read advanced monographs and some research
articles on algebraic combinatorics and related topics for research purposes.

Will this course be scheduled as a cross-
level cross listed section?

Attach Syllabus
  Syll-AC-generic.pdf

Additional
Attachments

Staffing:
  Geir Agnarsson, Jim Lawrence, Neil Epstein.

Relationship to
Existing Programs:
  This course will supplement and strengthen the Math PhD and MS programs.

Relationship to
Existing Courses:
  The course is a deeper look at certain aspects of Graph Theory and Combinatorics not covered in any other
  courses in our program.

Have you reached out to the Libraries to determine whether there are adequate resources to
support your course? If not, please email Meg Meiman, Associate University Librarian for
Learning, Research, and Engagement at mmeiman2@gmu.edu.
                        No

Additional
Comments:

Reviewer
Comments

Key: 19258

GEORGE
MASON
UNIVERSITY

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Department of Mathematical Sciences
4400 University Drive, Fairfax, VA 22030
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Algebraic Combinatorics

Generic sample

Description/Purpose: This course will serve as an introduction to the application of commutative algebra in combinatorics and as a possible bridge between these two hitherto independent topics; commutative algebra (including rings, modules and fields) and combinatorics (including graph theory, enumeration and discrete geometry). We will use abstract algebra and some algebraic topology as important tools to tackle and solve some combinatorial problems. Since the fundamental purpose will be to obtain combinatorial results, the course is called "*algebraic combinatorics*", but it might as well be called "*commutative algebra in combinatorics*" if one prefers to put more weight on the algebraic tools themselves, instead of the final combinatorial interpretation. – It will be demonstrated that algebraic techniques are powerful and indispensable in numerous combinatorial investigations.

Learning outcomes: It is expected that after this course it should be clear that a firm knowledge in commutative algebra is necessary for the working combinatorist, just as it is for many other branches of mathematics like functional analysis and algebraic topology. Finally, we hopefully will have covered enough topics in algebra and combinatorial applications for the attenders to be able to read advanced monographs and some research articles on algebraic combinatorics and related topics for research purposes.

Catalog Description / Material: Selected topics on the following: (i) convex polytopes, (ii) simplicial complexes, (iii) f-vectors and h-vectors, (iv) Cohen-Macaulay rings, (v) Hilbert functions and Hilbert series, (vi) Stanley-Reisner rings (aka face rings), (vii) Cohen-Macaulay complexes, (viii) Shellability.

Prerequisites: Most important is to have mathematical maturity and an open mind. Roughly what I expect is listed as follows:

- Required – MATH – 621, Algebra (First year graduate course), or equivalent.

- Preferred – MATH – 325, Discrete Mathematics II, or equivalent.

Suggested Course Number: MATH – 720 (Combinatorial Structures is MATH – 723 and this course should have a "close" number)

Possible Texts: The lectures will be self contained and mostly be based on notes and posted pdf files. The material making up these lecture notes will be taken from several classic books, monographs and recent research articles.

Below is a list of the most relevant classic textbooks, from which a bulk of the lectures will be taken.

1. Arne Brøndsted, *An Introduction to Convex Polytopes*, Graduate Texts in Mathematics (GTM-90), Springer Verlag, New York, (1983).

2. Takayuki Hibi, *Algebraic Combinatorics; on Convex Polytopes*, Carslaw Publications, (1992).

3. Richard P. Stanley, *Combinatorics and Commutative Algebra*, 2nd Edition, Progress in Mathematics (PM-41), Birkhäuser, Boston, (1996).

Possible Instructors: Geir Agnarsson, Jim Lawrence, Neil Epstein.

Assessment: About $3 - 4$ homework projects (HW) will be assigned throughout the semester.

Grading: The final letter grade for this course will be based on participation and homework. A, A- : $80 - 100\%$, B, B+ : $70 - 79\%$, C : $60 - 69\%$, F : Below.

AI, Chat-GPT etc: Currently it is easy to obtain as good as complete solutions to many homework problems by the use of Artificial Intelligence (AI) tools like Chat-GPT which is currently pretty smart, at least for undergraduate mathematical material and some beginning graduate material. The use of such tools is strongly discouraged if you want to develop an understanding of the material.

Please keep in mind that Chat-GPT, and many AI tools in general, are still known to make grotesque, erroneous claims (even in a self-assured and cocky manner!) especially when it comes to more advanced mathematics like what is covered in this course.

Sample Week by Week for the Course:
1. Convex Polytopes and Simplicial Complexes.
2. Simplicial Polytopes, Boundary Complexes, Face Posets.
3. f-vectors and h-vectors and their properties.
4. The Kruskal-Katona Theorem and Prerequisites.
5. Main ideas of the proof of the Kruskal-Katona Theorem.
6. Simplicial Complexes and Spheres.
7. The Dehn-Sommerville Equations.
8. The Moment curve and the Upper Bound Theorem (UBT).
9. M-vectors and Cohen-Macaulay rings.
10. Graded Ideals and Grades Algebras over Fields. Hilbert Basis Theorem.
11. Krull Dimension and System of Parameters.
12. Noether Normalization Theorem.
13. Stanley's Proof of the UBT using Reisner's Topological Theorem.
14. Reduced Homology, Cohen-Macaulay Complexes and Shellability.

Geir Agnarsson
February 23, 2026

Common Policies Affecting All Courses at George Mason University
Updated August 2025

These four policies affect students in all courses at George Mason University. This Course Policy Addendum must be made available to students in all courses (see Catalog Policy AP.2.5).

Additional policies affecting this course, and additional resources or guidance regarding these policies, may be provided to students by the instructor.

Academic Standards

Academic Standards exist to promote authentic scholarship, support the institution's goal of maintaining high standards of academic excellence, and encourage continued ethical behavior of faculty and students to cultivate an educational community which values integrity and produces graduates who carry this commitment forward into professional practice.

As members of the George Mason University community, we are committed to fostering an environment of trust, respect, and scholarly excellence. Our academic standards are the foundation of this commitment, guiding our behavior and interactions within this academic community. The practices for implementing these standards adapt to modern practices, disciplinary contexts, and technological advancements. Our standards are embodied in our courses, policies, and scholarship, and are upheld in the following principles:

- **Honesty:** Providing accurate information in all academic endeavors, including communications, assignments, and examinations.

- **Acknowledgement:** Giving proper credit for all contributions to one's work. This involves the use of accurate citations and references for any ideas, words, or materials created by others in the style appropriate to the discipline. It also includes acknowledging shared authorship in group projects, co-authored pieces, and project reports.

- **Uniqueness of Work:** Ensuring that all submitted work is the result of one's own effort and is original, including free from self-plagiarism. This principle extends to written assignments, code, presentations, exams, and all other forms of academic work.

Violations of these standards—including but not limited to plagiarism, fabrication, and cheating—are taken seriously and will be addressed in accordance with university policies. The process for reporting, investigating, and adjudicating violations is outlined in the university's academic standards procedures. Consequences of violations may include academic sanctions, disciplinary actions, and other measures necessary to uphold the integrity of our academic community.

The principles outlined in these academic standards reflect our collective commitment to upholding the highest standards of honesty, acknowledgement, and uniqueness of work. By adhering to these principles, we ensure the continued excellence and integrity of George Mason University's academic community.

Student responsibility: Students are responsible for understanding how these general expectations regarding academic standards apply to each course, assignment, or exam they participate in; students should ask their instructor for clarification on any aspect that is not clear to them.

Accommodations for Students with Disabilities

Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit the [Disability Services website](#) for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu. Phone: (703) 993-2474.

Student responsibility: Students are responsible for registering with Disability Services and communicating about their approved accommodations with their instructor *in advance* of any relevant class meeting, assignment, or exam.

FERPA and Use of GMU Email Addresses for Course Communication

The [Family Educational Rights and Privacy Act (FERPA)](#) governs the disclosure of [education records for eligible students](#) and is an essential aspect of any course. **Students must use their GMU email account** to receive important University information, including communications related to this class. Instructors will not respond to messages sent from or send messages regarding course content to a non-GMU email address.

Student responsibility: Students are responsible for checking their GMU email regularly for course-related information, and/or ensuring that GMU email messages are forwarded to an account they do check.

Title IX Resources and Required Reporting

As a part of George Mason University's commitment to providing a safe and non-discriminatory learning, living, and working environment for all members of the University community, the University does not discriminate on the basis of sex or gender in any of its education or employment programs and activities. Accordingly, **all non-confidential employees, including your faculty member, have a legal requirement to report to the Title IX Coordinator, all relevant details obtained directly or indirectly about any incident of Prohibited Conduct** (such as sexual harassment, sexual assault, gender-based stalking, dating/domestic violence). Upon notifying the Title IX Coordinator of possible Prohibited Conduct, the Title IX Coordinator will assess the report and determine if outreach is required. If outreach is required, the individual the report is about (the "Complainant") will receive a communication, likely in the form of an email, offering that person the option to meet with a representative of the Title IX office.

For more information about non-confidential employees, resources, and Prohibited Conduct, please see [University Policy 1202](#): Sexual and Gender-Based Misconduct and Other Forms of Interpersonal Violence. Questions regarding Title IX can be directed to the Title IX Coordinator via email to TitleIX@gmu.edu, by phone at 703-993-8730, or in person on the Fairfax campus in Aquia 373.

Student opportunity: If you prefer to speak to someone *confidentially*, please contact one of Mason's confidential employees in [Student Support and Advocacy](#) (SSAC), [Counseling and Psychological Services](#) (CAPS), [Student Health Services](#) (SHS), and/or the [Office of the University Ombudsperson](#).