

GEOMETRY

MA4510 **SYLLABUS** Fall 2007

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Office Hours

Course Web Page

TEXTBOOK: *College Geometry: a discovery approach*, 2nd Edition, David C. Kay, Addison Wesley Longman, 2001

Prerequisites: Calculus & Analytic Geometry II – MA2320, Mathematical Logic & Set Theory – MA2030

COURSE DESCRIPTION: This course discusses axiomatic synthetic plane geometry based on ruler and protractor measurement. Emphasis is placed on proof, historical development, and the use of Geometer's Sketchpad software (or equivalent).

COURSE OBJECTIVES: Upon successful completion of this course students should: be able to prove the results of high school geometry, demonstrate the independence of a result from an axiom system via a model, have a sense of the historical development of axiomatic plane geometry, and be proficient using Geometer's Sketchpad software (or equivalent).

COURSE EVALUATION & GRADING: Your grade for the course will be based on your homework performance, tests, and a comprehensive final exam. The grading scale is as follows:

A = [93, 100] A⁻ = [90, 92]	B⁺ = [87, 89]	C⁺ = [77, 79]	D⁺ = [67, 69]	F = [0, 59]
	B = [83, 86]	C = [73, 76]	D = [63, 66]	
	B⁻ = [80, 82]	C⁻ = [70, 72]	D⁻ = [60, 62]	

TUTORIAL

Drop-in tutorial is available in the mathematics learning center, Room A118.

TOPICS TO BE COVERED

AXIOMATICS, MODELS, AND INCIDENCE GEOMETRY (2-3 WEEKS)

- *Logic, proof, sets, relations, functions, equivalence relations
- Axiomatics, models, consistency, independence, categoricalness
- Incidence axioms
- Parallel properties: Euclidean, hyperbolic, elliptic
- Models and non-models of incidence geometry
- *Affine and projective planes
- *Finite incidence geometries
- *Projective duality
- *Projective Completion

PLANE GEOMETRY BASED ON RULE AND PROTRACTOR MEASUREMENT (2-3 WEEKS)

- Rule postulate and ruler placement theorem
- *Independence of ruler postulate
- Betweenness, segments, rays, angles, triangles
- Segment addition, subtraction, and construction lemmas
- Convexity and line separation
- Plane separation postulate
- *Independence of plane separation postulate
- *Pasch's postulate
- *Angle interior and crossbar theorem
- Protractor postulate
- *Non-independence of protractor postulate
- Angle addition, subtraction, and construction lemmas
- Angle-segment construction lemma
- Angles: adjacent, linear, vertical, supplementary, complimentary, acute, right, obtuse
- Dropping a perpendicular, lines with common perpendicular, existence of parallel lines
- *Inconsistency of elliptic parallel postulate
- *Alternative axioms systems

NEUTRAL GEOMETRY (2-3 WEEKS)

- SAS postulate
- *Taxicab geometry and independence of SAS postulate
- Triangle congruence criteria: ASA, SSS, AAS, SSA
- Isosceles triangle theorem
- Perpendicular bisector theorem
- Exterior angle inequality, scalene inequality, triangle inequality, SAS inequality
- Saccheri-Legendre theorem
- Circles, quadrilaterals
- *Convex quadrilateral congruence criteria: SASAS, ASASA, SASAA, SASSS
- *Saccheri and Lambert Quadrilaterals

EUCLIDEAN GEOMETRY (2-3 WEEKS)

- Euclidean parallel postulate
- *Independence of Euclidean parallel postulate
- Alternate interior angles, triangle exterior angles, triangle angle sums
- Trapezoids, parallelograms, parallel projection
- Triangle similarity criteria: AA, SAS, SSS
- Pythagorean theorem, trigonometry, laws of sines, law of cosines
- *Area

* Supplementary topics

CONTEMPORARY EUCLIDEAN GEOMETRY

- Power of a point theorems
- Menelaus's theorem, Ceva's theorem
- Classical triangle centers
- Nine-point circle
- Tilings
- Dissections

GEOMETRIC CONSTRUCTIONS

- Straightedge and compass constructions
- Regular polygons and Gauss's theorem
- Classical Greek construction problems
- Constructible numbers and nonsolvability of Greek problems by straightedge and compass
- Origami constructions
- Origami constructible numbers

HYPERBOLIC GEOMETRY

- Hyperbolic parallel postulate
- Independence of hyperbolic parallel postulate
- Defect
- Triangle similarity
- Absolute length
- Beltrami-Klein model, Poincaré disk model, Poincaré half-plane model
- Circular inversion
- Trigonometry

ISOMETRIES (MOTIONS)

- Reflections, translations, rotations, glide reflections
- Classification of isometries
- Symmetry groups

OTHER GEOMETRIES

- Algebraic geometry
- Analytic geometry
- Differential geometry
- Higher dimensional geometry
- Riemannian (elliptic) geometry
- Spherical (double elliptic) geometry