

BACHELOR OF SCIENCE PROGRAM IN MATHEMATICS
BACHELOR OF SCIENCE (MATHEMATICS)
B.Sc. (MATHEMATICS)
FACULTY OF SCIENCE AND TECHNOLOGY
THAMMASAT UNIVERSITY

1. STRUCTURE AND COMPONENT		
1.1	General Education Courses	30 credits
1.2	Major Compulsory Courses	101 credits
1.3	Free Electives Courses	6 credits
Total		137 credits

2. DETAILS OF THE CURRICULUM				
2.1	General Education Courses			30 credits
Part I	University Compulsory and Prescribed			21 credits
	TU 110	Integrated Humanities	3	credits
	TU 120	Integrated Social Sciences	3	credits
	TU 130	Integrated Sciences and Technology	3	credits
	TH 161	Thai Usage	3	credits
	TU 154	Foundation of Mathematics	3	credits
	EL 171	English Course 2	3	credits
	EL 172	English Course 3	3	credits
Part II	Department Compulsory and Prescribed			9
	BA 291	Introduction of Business	3	credits
	EC 210	Introductory Economics	3	credits
	And select 3 credits from the following courses :			
	PY 228	Psychology of Interpersonal Relations	3	credits
	HO 201	Principle of Management	3	credits

2.2	Major Compulsory Courses	101	credits
2.2.1	Basic Courses in Science and Mathematics	12	credits
	SC 113 General Biology	3	credits
	SC 163 General Biology Laboratory	1	credits
	SC 123 Fundamental Chemistry	3	credits
	SC 173 Fundamental Chemistry Laboratory	1	credits
	SC 135 General Physics	3	credits
	SC 185 General Physics Laboratory	1	credits
2.2.2	Compulsory Courses	50	credits
	MA 211 Calculus 1	3	credits
	MA 212 Calculus 2	3	credits
	MA 213 Calculus 3	3	credits
	MA 221 Elementary Logic and Set Theory	3	credits
	MA 313 Ordinary Differential Equations	3	credits
	MA 315 Mathematics Analysis 1	3	credits
	MA 331 Abstract Algebra 1	3	credits
	MA 332 Linear Algebra	3	credits
	MA 351 Numerical Methods	3	credits
	MA 412 Functions of Complex Variables	3	credit
	MA 461 Seminar	2	credits
	ST 211 Statistics 1	3	credits
	ST 321 Probability Theory 1	3	credits
	CS103 Introduction to Computer Programming	3	credits
	CS112 Introduction to Object Oriented Programming	3	credits
	EG 221 Reading for Information	3	credits
	or EL 295 Academic English 1		
	EG 241 Listening-Speaking 1	3	credits
	or EL 395 Academic English 2		
* Students are required to earn at least a C grade in the following 5 courses : MA 211, MA 212, MA 221, MA 313 and MA 332			
2.2.3	Specialized Elective Courses	21	credits
	(Student are required to select at least 6 credits of 400 level)		

MA 316	Vector Analysis	3 credits
MA 317	Advanced Calculus	3 credits
MA 318	Partial Differential Equations	3 credits
MA 327	Set Theory	3 credits
MA 337	Number Theory	3 credits
MA 346	Projective Geometry	3 credits
AM 319	Mathematical Programming 1	3 credits
AM 326	Graph Theory and Applications	3 credits
AM 327	Combinatorial Mathematics and Applications	3 credits
ST 212	Statistics 2	3 credits
ST 322	Mathematical Statistics 1	3 credits

Elective Course of 400 level (Minimum 6 credits)

MA 416	Mathematical Analysis 2	3 credits
MA 426	Elementary Topology	3 credits
MA 436	Abstract Algebra 2	3 credits
MA 446	Differential Geometry	3 credits
MA 447	Transformational Geometry	3 credits
MA 476	Mathematics Packages	3 credits
AM 418	Optimization Technique	3 credits

****Elective Courses non-credits for major**

MA 111	Fundamentals of Calculus
MA 112	Analysis Geometry and Applied Calculus
MA131	Applied Linear Algebra
MA 214	Differential Equations
MA 216	Calculus for Social Science 1
MA 217	Calculus for Social Science 2
MA 218	Calculus for Science 1
MA 219	Calculus for Science 2
MA 236	Linear Algebra and Elementay Differential Equations
MA 251	Numerical Methods and Applications

MA 286 Calculus and Elementary Differential for Bioscience

2.2.4 Minor or Electives Courses, of not less than 18 credits

Students may choose one of two forms

2.2.4.1 Minor Course

Student may choose to take a minor course from the other faculties.

2.2.4.2 Electives Courses

Student may choose to take any courses that offer in the university and not more than 4 majors, not less than 18 credits (not included major course)

2.3 Free Elective Courses at least 6 credits

Student may choose to take any courses that offered in the University at least 6 credits including any of the foreign language offered in the University General Education Courses

Student can not choose to take the following courses to be free Elective courses

1. All basic Science and Mathematics courses (include courses that are not defined to be general Education courses part II)
2. General Education courses both part I and II that use all "TU"

3. THE MINOR IN MATHEMATICS

The minimum requirement is an accumulation of 18 credits in statistics, and the following condition to be fulfilled

3.1 Having taken 12 credits from the following courses

MA 211 Calculus 1

MA 212 Calculus 2

MA 213 Calculus 3

MA 332 Linear Algebra

***** Students are required to earn at least a C grade in the following courses :
MA 211, MA 212 and MA 332**

****** Students that take compulsory courses: MA 216 and MA 217 or MA 218 and MA 219 or MA 111 and MA 112 and earn at least a C grade can use MA 216 and MA 217 or MA 218 MA 219 or MA 111 and MA 112 instead of MA 211 and MA 212. Furthermore students that take compulsory courses: MA 236 and MA 131 and earn at least a C grade can use MA 236 MA 131 instead of MA 332**

3.2 Not less than 6 credits of the elective courses and having maintained a grade point average of 2.00 or higher including the following courses:

MA 221	Elementary Logic and Set Theory	3	credits
MA 313	Ordinary Differential Equations	3	credits
MA 315	Mathematics Analysis 1	3	credits
MA 316	Vector Analysis	3	credits
MA 331	Abstract Algebra 1	3	credits
MA 351	Numerical Methods	3	credits
MA 426	Elementary Topology	3	credits
MA 476	Mathematics Packages	3	credits

4. Associate Degree in Mathematics

Students with an accumulation of not less than 96 credits in pursuit of courses in the university are entitled to an Associate Degree in Mathematics under the following conditions:

4.1 Having maintained a grade point average not less than 2.00.

4.2 Having been registered as a full-time student for at least five semesters.

4.3 Having fulfilled the University General Education Courses of 30 credits and Basic Science and Mathematics Courses of 12 credits.

4.4 Having taken not less than 48 credits of the courses in the Department:

4.4.1 Compulsory Courses of Mathematics

MA 211	Calculus 1	3	credits
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MA 212	Calculus 2	3	credits
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MA 213	Calculus 3	3	credits
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MA 221	Elementary Logic and Set Theory	3	credits
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MA 313	Ordinary Differential Equations	3	credits
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MA 315	Mathematics Analysis 1	3	credits
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MA 331	Abstract Algebra 1	3	credits
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MA 332	Linear Algebra	3	credits
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MA 351	Numerical Methods	3	credits
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4.4.2 Specialized Elective Courses, of not less than 9 credits

MA 316	Vector Analysis	3	credits
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MA 317	Advanced Calculus	3	credits
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MA 318	Partial Differential Equations	3	credits
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MA 327	Set Theory	3	credits
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MA 337	Number Theory	3	credits
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MA 346	Projective Geometry	3	credits
MA 416	Mathematical Analysis 2	3	credits
MA 426	Elementary Topology	3	credits
MA 436	Abstract Algebra 2	3	credits
MA 446	Differential Geometry	3	credits
MA 447	Transformational Geometry	3	credits
MA 476	Mathematics Packages	3	credits
AM 319	Mathematical Programming 1	3	credits
AM 326	Graph Theory and Applications	3	credits
AM 327	Combinatorial Mathematics and Applications	3	credits
AM 418	Optimization Technique	3	credits
ST 212	Statistics 2	3	credits
ST 322	Mathematical Statistics 1	3	credits
4.4.3 Compulsory Courses			
ST 211	Statistics 1	3	credits
ST 321	Probability Theory 1	3	credits
CS 103	Introduction to Computer Programming	3	credits
CS 112	Introduction to Object-Oriented Programming	3	credits
4.5	Having taken not less than 6 credits Free Elective courses		

5. Mathematics Courses

NO.	CODE	COURSE NAME	CREDITS
1	MA 111	Fundamentals of Calculus	3
2	MA 112	Analytic Geometry and Applied Calculus	3
3	MA 113	Calculus and Analytic Geometry	3
4	MA 131	Applied Linear Algebra	3
5	MA 211	Calculus 1	3
6	MA 212	Calculus 2	3
7	MA 213	Calculus 3	3
8	MA 214	Differential Equations	3
9	MA 216	Calculus for Social Science 1	3
10	MA 217	Calculus for Social Science 2	3
11	MA 218	Calculus for Science 1	3

12	MA 219	Calculus for Science 2	3
13	MA 221	Elementary Logic and Set Theory	3
14	MA 236	Linear Algebra and Elementary Differential Equations	3
15	MA 251	Numerical Methods and Applications	3
16	MA 286	Calculus and Elementary Differential for Bioscience	3
17	MA 313	Ordinary Differential Equations	3
18	MA 315	Mathematics Analysis 1	3
19	MA 316	Vector Analysis	3
20	MA 317	Advanced Calculus	3
21	MA 318	Partial Differential Equations	3
22	MA 327	Set Theory	3
23	MA 331	Abstract Algebra 1	3
24	MA 332	Linear Algebra	3
25	MA 337	Number Theory	3
26	MA 346	Projective Geometry	3
27	MA 351	Numerical Methods	3
28	MA 412	Functions of Complex Variables	3
29	MA 416	Mathematical Analysis 2	3
30	MA 426	Elementary Topology	3
31	MA 436	Abstract Algebra 2	3
32	MA 446	Differential Geometry	3
33	MA 447	Transformational Geometry	3
34	MA 461	Seminar	2
35	MA 476	Mathematics Packages	3

6. Study Plan

First Year					
First Semester		Credit	Second Semester		credits
TU 154	Foundation of Mathematics	3	MA 212	Calculus 2	3
SC 135	General Physics	3	SC 113	General Biology	3
SC 185	General Physics Laboratory	1	SC 163	General Biology Laboratory	1
TH 161	Thai Usage	3	SC 123	Fundamental Chemistry	3
MA 211	Calculus 1	3	SC 173	Fundamental Chemistry Laboratory	1
TU 110	Integrated Humanities	3	ST 211	Statistics 1	3
English Language		3	English Language		3
			TU 130	Integrated Sciences and Technology	3
Total		19	Total		20

Second Year					
First Semester		Credit	Second Semester		credits
MA 213	Calculus 3	3	MA 332	Linear Algebra	3
MA 221	Statistics 2	3	ST 321	Introduction to Probability Theory	3
EG 221	Reading for Information	3	EG 241	Listening-Speaking 1	3
or			or		
EL 295	Academic English 1		EL 395	Academic English 2	
TU 120	Integrated Social Sciences	3	EC 210	Introductory Economics	3
BA 291	Introduction of Business	3	CS 103	Introduction to Computer Programming	3
Free Elective Course		3	Minor or Elective Course		3
General Education Course Part II		3			
Total		21	Total		18

Third Year					
First Semester		Credit	Second Semester		credits
CS 112	Introduction to Object-Oriented Programming	3	MA 351	Numerical Methods	3
MA 313	Ordinary Differential Equations	3	MA 331	Abstract Algebra 11	3
MA 315	Mathematics Analysis	3	Minor or Elective Course		3
Minor or Elective Course		6	Elective Courses in Mathematics level 300 or 400		6
Elective Courses in Mathematics level 300 or 400		3	Free Elective Course		3
Total		18	Total		18

Fourth Year					
First Semester		Credit	Second Semester		credits
MA 412	Functions of Complex Variables	3	Elective Courses in Mathematics level 400		3
MA 461	Seminar	2	Minor or Elective Course		3
Elective Courses in Mathematics level 300 or		6			

400			
Minor or Elective Course	3		
Elective Courses in Mathematics level 400	3		
Total	17	Total	6

7. COURSE DESCRIPTIONS

MA 111 Fundamentals of Calculus 3 credits

Prerequisite -

The elementary number system and functions, calculus of one variable functions, limit, continuity, the derivative and its applications, antiderivatives, techniques of integrations and its applications, series, Taylor's Theorem and its applications.

Note : There is no credit for students who studying or passed MA111 or MA216 or MA218

MA 112 Analytic Geometry and Applied Calculus 3 credits

Prerequisite MA 111

Analytic geometry for conic sections and second degree equations, vectors, transformation of coordinates, polar coordinates and graph drawing, functions of several variables, partial derivatives, multiple integrals, scalar fields and vector fields, derivative of vector valued functions, integration in the vector fields, Gauss's Theorem, Green's Theorem and Stoke's Theorem, Fourier and Laplace analysis and theirs applications.

MA 113 Calculus and Analytic Geometry 3 credits

Prerequisite -

Calculus of one variable functions, limit, continuity, the derivative and its applications, antiderivatives, techniques of integrations and its applications, Taylor's series transformation of coordinates, polar coordinates and graph drawing, functions of several variables, partial derivatives, multiple integrals.

MA 131 Applied Linear Algebra 3 credits

Prerequisite -

Theorems of matrices, Hermitian matrices and unitary matrices, LU-factorizations, vector

spaces, linear independence, dimensions, rank of matrices, applications of matrices for solving systems of linear equations, inverse of matrices, determinant, Cramer's Rule, linear transformations, inner product spaces, orthogonal complement and least square, eigenvalues, eigenvectors and its application, diagonalization of matrices, basic concepts of tensor.

Note : There is no credit for students who studying or passed MA236

MA 211	Calculus 1	3 credits
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Prerequisite -

Limits and continuous functions, derivatives of algebraic and transcendental functions, the chain rule, implicit differentiation, higher-order derivatives, Rolle's theorem, the mean value theorem, applications of the derivative, differentials and applications, antiderivatives, indefinite integrals, formula of integration, integration by change variables, differential equations, Riemann sum, definite integrals, the fundamental theorem of calculus, applications of the definite integrals in geometry and physics.

Note : There is no credit for students who studying or passed MA111 or MA216 or MA218

MA 212	Calculus 2	3 credits
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Prerequisite MA 211

Indeterminate forms, L'Hospital's rule and its application for finding the limits, techniques of integration, improper integrals and test for convergence, polar coordinate system, graphing in polar coordinates, area in polar coordinates, parametric equations, derivatives in polar coordinates, sequences, series, convergence tests for series, power series, Maclaurin series, Taylor series, differentiation and integration of power series.

MA 213	Calculus 3	3 credits
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Prerequisite MA 212 or MA 112 or MA 217 or MA 219

Functions of several variables, three dimensional space in rectangular coordinates and graph drawing, vectors, lines and planes in 3-space, limits and continuity of functions of several variables, partial derivatives, the chain rule and its applications, directional derivatives, gradients, total differentiation and its applications, implicit functions theorem, higher-order partial derivatives, maximum and minimum of functions of several variables with unconstraint and constraint, multiple integrals, Jacobian, change of variables in multiple integrals, cylindrical coordinates, spherical coordinates, applications of multiple integrals.

MA 214	Differential Equations	3 credits
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Prerequisite	MA 112 or MA 113
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First order differential equations, second order differential equations, homogeneous linear differential equations, nonhomogeneous linear differential equations, differential equations of higher order, series solution of linear differential equations, special functions, partial differential equations, the Laplace transform and Fourier transform, introduction to nonlinear differential equations, applications engineering problem solving.

MA 216	Calculus for Social Science 1	3 credits
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Prerequisite	-
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Limits and continuity of one variable functions, derivatives of algebraic functions and transcendental functions, implicit differentiation, higher order derivatives, Roll's theorem, the mean value theorem, applications of derivative for determining limits and maximum and minimum of functions, differentials and its applications, antiderivatives, indefinite integrals and integration, definite integrals and application of area solving, functions of several variables, limits and continuity of functions of several variables, partial derivatives, the chain rule, total differential and its applications.

Note : There is no credit for students who studying or passed MA111 or MA211 or MA218

MA 217	Calculus for Social Science 2	3 credits
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Prerequisite	MA 216
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Matrices, determinants, solutions of system of linear equations, higher order partial derivatives, application of maximum and minimum of several variables functions with unconstraint and constraint, techniques of integration for one variable functions, polar coordinates and area in polar coordinates, multiple integration and its applications.

MA 218	Calculus for Science 1	3 credits
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Prerequisite	-
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Limits and continuity of functions, derivatives of algebraic functions and transcendental functions, the chain rule, derivative of implicit functions, higher order derivatives, Roll's theorem, the mean valued theorem, applications of derivative, differential and its applications,

examples in engineering problem solving, error analysis, numerical solutions of systems of linear equations (direct methods and iteration methods), numerical methods in determining eigenvalues and eigenvectors, finite elements, solving engineering problems by using package program.

MA 286	Calculus and Elementary Differential for Bioscience	3 credits
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Prerequisite MA 218

Improper integrals, functions of several variables, limits and continuity of functions of several variables, partial derivatives and the interpretation in geometry, higher order partial derivatives, implicit partial differentiation, the chain rules, total differentials and its applications, maxima and minima of functions of two variables and its applications, differential equations, method of determining general solutions and particular solution of differential equations and the application in modeling of science problems, systems of differential equations and its applications.

MA 313	Ordinary Differential Equations	3 credits
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Prerequisite MA 112 or MA 213 or MA 217 or MA 219

First order differential equations, theorems on linear differential equations, second order linear differential equations, differential equations with constant coefficients, method of undetermined coefficients, method of variation of parameters, higher order linear differential equations, Euler equations, the Laplace transform, the convolution theorem, linear systems of first order differential equations, elementary partial differential equations.

Note : There is no credit for students who studying or passed MA214

MA 315	Mathematical Analysis 1	3 credits
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Prerequisite MA 213

Real number system, topology on real numbers, open sets, closed sets and neighbourhoods, Bolzano–Weierstrass theorem, limits and continuity, uniform continuity, derivative of functions of one variable, maximum and minimum of functions, Riemann integrals.

MA 316	Vector Analysis	3 credits
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Prerequisite MA 112 or MA 213 or MA 217 or MA 219

Vectors, algebra of vectors, vector-valued functions, parametric equations of curves and surfaces, derivatives of vectors, line integrals, surface integrals and volume integrals, integral theorems of vector analysis, introduction to tensors.

MA 317 Advanced Calculus 3 credits

Prerequisite MA 112 or MA 213 or MA 217 or MA 219

Sequences and series of functions, tests of convergence, properties of uniform convergence of sequences and series of functions with continuity, derivatives and integrals, Taylor's formulas and approximations, differentiation of functions in the integral forms, gamma and beta functions, Fourier series, Fourier integral and transform.

MA 318 Partial Differential Equations 3 credits

Prerequisite MA 313 or MA 214 or MA 286

Partial differential equations, the heat equations, the wave equations and Laplace equations, separation of variables and linear property, Green's formula and applications in boundary value problems, variation of parameters, application of Laplace and Fourier transformation to partial differential equations.

MA 327 Set Theory 3 credits

Prerequisite MA 221

Zermelo 's set theory, ordinal numbers, cardinal numbers, axiom of choice and its equivalences, the foundation of real number system.

MA 331 Abstract Algebra 1 3 credits

Prerequisite MA 221

Groups and elementary properties of groups, abelian groups, groups of integers modulo n , groups of permutations and symmetric groups, subgroups and Lagrange's theorem, cyclic groups, normal subgroups and quotient groups, homomorphisms and isomorphisms of groups, rings and elementary properties of rings, subrings, integral domain, ideals, ring homomorphisms and ring isomorphisms, fields.

MA 332	Linear Algebra	3 credits
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Prerequisite	2 nd year student
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Matrices, algebra of matrices, elementary operations and elementary matrices, rank of a matrix, determinants, inverse of matrices, system of linear equations and solutions, Cramer's rule, vector spaces, bases and dimension of vector space, linear transformation, eigen values, eigen vectors, diagonalization of a matrices, inner product spaces, Gram-Schmidt process, applications of linear algebra.

MA 337	Number Theory	3 credits
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Prerequisite	MA 221
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Integers, Euclidean algorithm and consequences, congruence with applications, cryptology, primitive roots, quadratic residue, continued fractions, diophantine equations.

MA 346	Projective Geometry	3 credits
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Prerequisite	MA 131 or MA 332
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Projective spaces, projective planes, projective transformations, Desargues Theorem, Pappus Theorem, duality, quadrics and conics, affine geometry.

MA 351	Numerical Methods	3 credits
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Prerequisite	MA 213 or MA 112 or MA 217 or MA 219
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Errors and effects, solutions of nonlinear equations, solutions of system of linear equations, solutions of system of nonlinear equations, interpolation, function approximating and curve fitting, numerical differentiation and integration, numerical solution of the first order ordinary differential equations.

Note : There is no credit for students who studying or passed MA251

MA 412	Functions of Complex Variable	3 credits
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Prerequisite	MA 213
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Complex numbers, functions of a complex variable, derivatives of functions of a complex variable, power series and analytic functions, integral of functions of a complex variable, Cauchy-goursat theorem, Laurent's series, residues, conformal mapping.

MA 416	Mathematical Analysis 2	3 credits
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Prerequisite	MA 315	
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Topology on \mathbb{R}^n , covering sets, Lindelöf of covering theorem and Heine-Borel covering theorem, theorems of Riemann-Stieltjes integrals, theorems of differentiation of functions of several variables, theorems of multiple integrations.

MA 426	Elementary Topology	3 credits
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Prerequisite	MA 315	
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Topological spaces and basic properties, open sets, closed sets and neighbourhoods, metric spaces, complete metric spaces, continuity and homeomorphisms, connectedness, compactness.

MA 436	Abstract Algebra 2	3 credits
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Prerequisite	MA 331	
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Group theory, alternating groups, elementary properties of finite abelian groups, normalizers, solvable groups, Sylow theorems, rings, division rings, integral domain, ideals and quotient rings, fields, the field of quotients, rings of polynomials and irreducible polynomial, remainder theorem, the fundamental theorem of algebra.

MA 446	Differential Geometry	3 credits
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Prerequisite	MA 316	
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Differential geometry of curves and surfaces, Frenet formulas, isoperimetric inequality, local theory of surfaces, Gaussian and mean curvature, Gauss-Bonnet Theorem.

MA 447	Transformational Geometry	3 credits
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Prerequisite	MA 332	
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Affine geometry and affine transformation, Euclidian geometry and transformation, non-Euclidian geometry.

MA 461	Seminar	3 credits
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Prerequisite	4 th year student
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Seminar on current interesting topics in mathematics or applied mathematics, students are required to write a report and present the selected topics.

MA 476	Mathematical Packages	3 credits
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Prerequisite	1. MA 313 and CS 103 And 2. MA 332
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Mathematical package programs, using program tools in geometry and algebra geometry including calculus and differential equation, implementation for graph drawing, applications of mathematical package programs in related fields.
