ACADEMIC SUBJECT: MATHEMATICS

Table 1: AS 1 Math Structure for BSc (Ed) (Primary 2 CS Track) AS 1 Math Structure for BSc (Ed) (Secondary)

Please refer to the NIE Portal for the list of courses offered by semesters

Year	Course Code	Title	Course Category	No. of AUs	Pre-requisites
1	AAM10A	Linear Algebra I	Core	3	-
	AAM10B	Calculus I	Core	3	-
	AAM10C	Finite Mathematics	Core	3	-
	AAM10D	Number Theory	Core	3	-
2	AAM20A	Linear Algebra II	Core	3	Must have done AAM10A
	AAM20B	Calculus II	Core	3	-
	AAM20C	Statistics I	Core	3	-
	AAM20D	Computational Mathematics	Core	3	-
	AAM20E	Differential Equations	Core	3	-
	AAM20G	Complex Analysis	Core	3	-
3	**Select any 3 electives**				
	AAM33A	Special Topics in Mathematics I	Pres	3	-
	AAM33C	Statistics II	Pres	3	-
	AAM33D	Real Analysis	Pres	3	-
	AAM33E	Modern Algebra	Pres	3	-
	AAM33G	Modelling with Differential Equations	Pres	3	AAM20E
	AAM33H	Statistics III	Pres	3	AAM33C
	AAM33J	Combinatorial Analysis	Pres	3	-
4	AAM40A	Academic Exercise: Mathematics**	Core	6	-
	Select any 3 electives				
	AAM43A	Special Topics in Mathematics II	Pres	3	-
	AAM43B	Statistical Theory	Pres	3	AAM33C
	AAM43C	Applied Statistics	Pres	3	AAM33C
	AAM43D	Techniques in Operations Research	Pres	3	-
	AAM43E	Mathematical Programming and Stochastic Processes	Pres	3	-
	AAM43G	Metric Spaces	Pres	3	AAM33D
	AAM43H	Galois Theory	Pres	3	AAM33E
	AAM43J	Graph Theory	Pres	3	-
	AAM43K	Geometry	Pres	3	-
	AAM43L	Advanced Mathematical Modelling	Pres	3	AAM20E
Total AUs for Degree				54	-

** This course spans two semesters. Student teachers should approach your respective academic groups for project details and the assignment of supervisors.

Table 2: AS 1 Math Structure for BSc (Ed) (Primary 3 CS Track)

Year	Course Code	Title	Course Category	No. of AUs	Pre-requisites
1	AAM10A	Linear Algebra I	Core	3	-
	AAM10B	Calculus I	Core	3	-
	AAM10C	Finite Mathematics	Core	3	-
	AAM10D	Number Theory	Core	3	-
2	AAM20A	Linear Algebra II	Core	3	Must have done AAM10A
	AAM20B	Calculus II	Core	3	-
	AAM20C	Statistics I	Core	3	-
	AAM20D	Computational Mathematics	Core	3	-
	AAM20E	Differential Equations	Core	3	-
	AAM20G	Complex Analysis	Core	3	-
3	**Select any 2 electives**				
	AAM33A	Special Topics in Mathematics I	Pres	3	-
	AAM33C	Statistics II	Pres	3	-
	AAM33D	Real Analysis	Pres	3	-
	AAM33E	Modern Algebra	Pres	3	-
	AAM33G	Modelling with Differential Equations	Pres	3	AAM20E
	AAM33H	Statistics III	Pres	3	AAM33C
	AAM33J	Combinatorial Analysis	Pres	3	-
4	AAM40A	Academic Exercise: Mathematics**	Core	6	-
	Select any 1 electives				
	AAM43A	Special Topics in Mathematics II	Pres	3	-
	AAM43B	Statistical Theory	Pres	3	AAM33C
	AAM43C	Applied Statistics	Pres	3	AAM33C
	AAM43D	Techniques in Operations Research	Pres	3	-
	AAM43E	Mathematical Programming and Stochastic Processes	Pres	3	-
	AAM43G	Metric Spaces	Pres	3	AAM33D
	AAM43H	Galois Theory	Pres	3	AAM33E
	AAM43J	Graph Theory	Pres	3	-
	AAM43K	Geometry	Pres	3	-
	AAM43L	Advanced Mathematical Modelling	Pres	3	AAM20E
Total AUs for Degree				45	-

Please refer to the NIE Portal for the list of courses offered by semesters.

** This course spans two semesters. Student teachers should approach your respective academic groups for project details and the assignment of supervisors.

Table 3: AS2 Math Structure for BA/BSc(Ed) (Secondary)

Please refer to the NIE Portal for the list of courses offered by semesters.

Year	Course Code	Title	Course Category	No. of AUs	Pre-requisites
1	AAM10A	Linear Algebra I	Core	3	-
	AAM10B	Calculus I	Core	3	-
	AAM10C	Finite Mathematics	Core	3	-
	AAM10D	Number Theory	Core	3	-
Total AUs for Degree				12	-

AAM10A Linear Algebra I

This first course in linear algebra aims to provide student teachers with the knowledge of basic set theory, linear systems, matrix algebra, determinant function, and vectors in 2-space, 3-space and general n-space. It will equip student teachers with the content knowledge for taking other courses, especially Linear Algebra II, which is the second course in linear algebra. It also provides student teachers with the opportunities to see the interlink between different structures in mathematics. Topics covered include: Basic set theory, linear systems and solutions, Gauss-Jordan elimination, matrices and matrix operations, invertible matrices, methods of finding inverse of a matrix, determinant function and applications, vectors in 2-space and 3-space, dot product, cross product, equations of straight lines and planes, n-space, Cauchy-Schwarz inequality.

AAM10B Calculus I

This course aims to introduce student teachers to concepts in beginning undergraduate calculus (of one variable) so that student teachers can have a deeper understanding of school calculus content knowledge and the advanced knowledge of calculus

so that they are prepared for Multivariable calculus and Real Analysis. This course also aims to give student teachers an introductory calculus related proofs in ε-δ definitions. Topics covered include: Functions and graphs, limits of functions, ε-δ definition of limits, Continuous functions and results (Intermediate Value Theorem), Differentiation and Derivative, techniques of differentiation and their results (Mean value Theorem and Rolle's Theorem), Applications of Differentiation (Rate of Change, Gradients of tangents and normal, Kinematics, Maxima and Minima, Analysis of Graphs of Functions), Riemann sums and Riemann integral, Antiderivative, Indefinite Integral Theorem and Fundamental Theorem of Calculus, Integration Techniques.

AAM10C Finite Mathematics

This core course aims to develop student teachers' mathematical problem solving skills by exposing them to a variety of counting problems and the principles and techniques used to solve them. It also aims to introduce student teachers to the fundamental concepts of discrete probability distributions. Topics covered include: Basic principles of counting, permutations and combinations, distributions, generalized permutations and combinations, Binomial Theorem and combinatorial identities, The Pigeonhole Principle, sample space and discrete probability distributions, conditional probability, independent events.

AAM10D Number Theory

The integers are the most fundamental objects in both school mathematics, as well as advanced mathematics. This first course in number theory aims to introduce student teachers to fundamental properties of integers. A secondary objective is to introduce student teachers to mathematical reasoning and methods of proofs by using integers as a context. Applications of number theory, which relate to our everyday lives, will also be discussed. Topics covered include: Understanding mathematical statements, methods of proof including proof by contradiction and mathematical induction, divisibility, greatest common divisors, Euclidean algorithm, Diophantine equations, primes and the Fundamental Theorem of Arithmetic, congruences and the Chinese Remainder Theorem, applications of congruences to divisibility tests and check digits. Fermat's Little Theorem and Euler's generation.

AAM20A Linear Algebra II

This is a second course in linear algebra, which builds on the concepts learned in Linear Algebra I. It aims to introduce student teachers to the fundamental concepts of real vector spaces and linear transformations. The materials covered in this core course, as well as in Linear Algebra I, form essential background for future study in all other areas of pure and applied mathematics. Topics covered include: Basic logic, real vector spaces, subspaces, linear independence, spanning sets, basis and dimension, row space, column space, nullspace, rank and nullity, orthogonality in Euclidean n-space, eigenvalues and eigenvectors, diagonalization, linear transformations.

AAM20B Calculus II

This is the second core course in calculus, which builds on the concepts learned in Calculus I. It aims to introduce student teachers to sequences and series, and the calculus of real-valued functions of two variables. Topics covered include: Sequences, ε-N definition of limit of sequence, limit theorems for sequences, monotonic and bounded sequences, infinite series, definition of convergence and sum of infinite series, various tests for convergence and divergence of series, absolute and conditional convergence, power series, interval and radius of convergence, differentiation and integration of power series, Taylor series and Maclaurin series. Partial derivatives for functions of two variables, differentiability and chain rules for functions of two variables, directional derivatives and gradients for functions of two variables, tangent planes, linearization, maxima and minima of functions of two variables, double integrals.

AAM20C Statistics I

This first course in statistics aims to introduce student teachers to the fundamental concepts in statistics. The course will provide a good foundation for study in further statistics topics and applications. Topics covered include: Discrete and continuous distributions. Mathematical expectations. Sampling distributions and Central Limit Theorem. Estimation, confidence intervals and hypothesis testing: one sample for mean, proportion and variance.

AAM20D Computational Mathematics

This course aims to teach student teachers how to exploit the power of modern computers as an experimental adjunct to support their theoretical understanding of mathematics. The course will cover the following suggested topics but with the option to substitute with other topics in mathematics where computing could be applied: Arithmetic and Number Theory: distribution of primes in the large number limit. Calculus and Analysis: graph plotting, numerical differentiation and integration. Geometry and Algebra: vector and matrix operations, transformations, fractals. Probability and Statistics: random numbers, simulation, the normal distribution. Other Programming Languages: appreciation of commonality of core concepts

AAM20E Differential Equations

This course aims to introduce student teachers to elementary theory and application of (ordinary) differential equations so that student teachers can have a deeper understanding of A-level differential equations and the advanced knowledge of ordinary differential equations so that they are prepared for advanced theory and modelling using differential equations. Topics covered include: Qualitative Theory of First Order Differential equations: Existence and Uniqueness Theorem, Slope fields. Analytic solution of some common first order differential equations (separable, linear, exact) and others that are reducible to the above forms by substitution. Modelling of some real world phenomena by first order differential equations (including population growth models, compartmental analysis, Newtonian mechanics of motion under

variable forces). Theory of second order differential equations (including liner dependence and independence of solutions to homogeneous linear differential equations and Wronskian). Solution of second order linear homogeneous differential equations with constant coefficients and other types of equations reducible to this (e.g. Euler's equation). Solution of second order non-homogeneous differential equations by method of undetermined coefficient and variation of parameters. Modelling of some real world phenomena by second order differential equations (including simple harmonic motion).

AAM20G Complex Analysis

This course deals with the theory of functions of one complex variable. The main objective of this course is to acquaint student teachers to complex valued functions of a special kind, namely the holomorphic (or analytic) functions. In this course, student teachers will learn more about the complex number system, its Euclidean topology as well as the theory of analytic functions. One ultimate goal is that student teachers are able to make use of complex integration and prove the Fundamental Theorem of Algebra. Topics covered include: Complex numbers in various representations, basic topology on the complex plane, limits and continuity, differentiability and analyticity, Cauchy-Riemann equations, examples of complex valued functions (polynomials, trigonometrical functions, exponential functions, branches of logarithmic functions), Contour integrals, Cauchy-Goursat Theorem, Deformation Principle, Cauchy Integral Formula, Residue Theorem, Fundamental Theorem of Algebra.

AAM33A Special Topics in Mathematics I

This course aims to cover some selected topics in mathematics that are not included in the regular course offerings. The contents and pre-requisites of this course may vary.

AAM33C Statistics II

This course in statistics is a continuation of the statistics course AAM20C. The course aims to provide a good foundation for study in further statistics topics and applications. Topics covered include: Two-sample confidence intervals and two-sample hypothesis testing for comparing means, proportions or variances; Chi-square goodness-of-fit tests, and contingency tables: test of homogeneity and test of independence; Simple linear regression: least squares estimation and inference (including diagnostic checking).

AAM33D Real Analysis

This course deals with the properties of real numbers in three aspects: order, algebra and topology. It also deals with fundamental notions of limits, continuity, differentiability and Riemann-integrability. The main objective of this course is to acquaint student teachers to real number system and the real-valued functions. In this course, student teachers will learn more about (1) the real number system: the completeness axiom, the Nested Interval Property, and the Bolzano-Weirestrass Theorem, and (2) properties of real-valued functions. One ultimate goal is that student teachers are able to prove the

Fundamental Theorem of Calculus. Topics covered include: The Completeness Axiom. The Archimedean Property. Density of rational and irrationals. The limit of a sequence, limit theorems. The limit of a function, the continuity of a function. The Intermediate Value Theorem. The Bolzano-Weierstrass Theorem. Extreme Value Theorem. Differentiation. Mean Value Theorem. Riemann Integration. The Fundamental Theorem of Calculus.

AAM33E Modern Algebra

This first course in abstract algebra aims to introduce student teachers to the algebraic structures of rings and groups, and to present a range of examples to facilitate the understanding of the abstract theory so that student teachers have a good grasp of the fundamental concepts in abstract algebra. This course will provide a good foundation for further study in advanced algebra topics and in areas where abstract algebra has applications. Topics covered include: Rings and subrings, integral domains and fields, ring isomorphism and homomorphism, rings of polynomials, divisibility in polynomial rings over a field, factorization of polynomials over a field, ideals and quotient rings of commutative rings with identity, First Isomorphism Theorem. Groups and subgroups, cyclic groups, permutations, symmetric group on n letters, cosets, Lagrange's Theorem, quotient groups, group isomorphism and homomorphism, Fundamental Homomorphism Theorems.

AAM33G Modelling with Differential Equations

The course aims to equip student teachers with the skills and knowledge of solving differential equations

using specific methods with a view to applying them in investigating real world problems through mathematical models. The course consists of five major topics: The Laplace Transform and its use in solving ordinary differential equations. Introduction to MATLAB and its application to mathematical problem solving. Numerical Solutions of Ordinary Differential Equations. Systems of Linear First-order Differential Equations. Plane Autonomous Systems

AAM33H Statistics III

Analysis of variance: completely randomized design, randomized block design, factorial designs. Non-parametric tests including sign test, Wilcoxon tests, rank correlation test.

AAM33J Combinatorial Analysis

This course aims to develop student teachers' mathematical problem solving skills by a variety of counting problems which can be solved by the general principle of inclusion-exclusion or generating functions. Topics covered include: Principle of inclusion-exclusion, general principle of inclusion-exclusion, Surjective mappings, the Stirling number of the second kind, derangement and Euler φ-functions; ordinary generating functions, operations of ordinary generating functions; some modelling problems, partitions of integers, and exponential generating functions.

AAM40A Academic Exercise: Mathematics

The Academic Exercise provides student teachers an opportunity to engage in independent learning and research under the guidance of an academic staff. It gives student teachers a chance to explore topics that may not be covered in the regular curriculum, and to investigate and solve mathematical problems related to those topics. This Academic Exercise enables student teachers to further hone their problem solving and communication skills.

AAM43A Special Topics in Mathematics II

This course aims to cover some selected advanced topics in mathematics that are not included in the regular course offerings. The contents and pre-requisites of this course may vary.

AAM43B Statistical Theory

Further univariate distributions. Bivariate distributions. Moment generating functions and proof of Central Limit Theorem. Sampling distributions: t-, F-, and chi-square distributions. Selected topics from estimation theory and hypothesis testing theory.

AAM43C Applied Statistics

Selected topics from multiple regression models, design of experiments.

AAM43D Techniques in Operations Research

Topics from the theory of networks: minimal spanning trees, shortest paths, maximal flows, critical path analysis. Topics from the advanced theory of networks: least cost flows, transportation problem, travelling salesman problem, dynamic programming.

AAM43E Mathematical Programming and Stochastic Processes

Selected topics from the theory of linear programming: the simplex algorithm, introduction to duality, sensitivity analysis, dual simplex algorithm, integer programming, non-linear programming. Selected topics from the theory of stochastic processes: queueing theory, probabilistic inventory models, project scheduling under uncertainty.

AAM43G Metric Spaces

Topology in R. Metric spaces. Open sets and closed sets. Convergence and completeness. Continuity and compactness. Equicontinuity, Arzela-Ascoli Theorem. Topological spaces.

AAM43H Galois Theory

Field extensions, simple, finite and algebraic extensions, constructions with straight-edge and compass, splitting fields, normal and separable extensions, primitive elements, finite fields, Galois groups, Galois extensions, The Fundamental Theorem of Galois Theory, solvability by radicals.

AAM43J Graph Theory

Graphs. Euler tours, Hamiltonian cycles, representations of graphs, isomorphisms of graphs, planar graphs. Trees and applications.
Selected topics from:
Connectivity and matching: Hall's theorem, transversals, Konig's theorem, vertex and edge cuts, Menger's theorem.
Colouring: vertex colouring, Brook's theorem, chromatic polynomials, map colouring and the four colour problem, edge colouring, Vizing's theorem.
Planarity: planar graphs, Kuratowski's theorem, Euler's formula, dual graphs.
Ramsey theory, extremal graphs.

AAM43K Geometry

The axiomatic approaches to various geometries, including finite geometries, Euclidean geometry, hyperbolic geometry and spherical geometry. Geometric transformations of the Euclidean plane, symmetries and isometries. Brief excursions to the classical projective geometry and the modern geometry of fractal.

AAM43L Advanced Mathematical Modelling

Introduction to partial differential equations (PDEs) and classification into elliptic, parabolic and hyperbolic PDEs. Analytical and numerical solutions of PDEs. Explicit and implicit finite difference techniques for time-dependent PDEs, such as the unsteady diffusion equation. Direct and iterative methods for solving systems of algebraic equations.

Application of numerical techniques for solving PDEs to industrial problems.