PART 6

The Far East

CHAPTER 15

Teaching Statistics at School Level in Malaysia

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15.1 SCHOOL STRUCTURE

The school educational system in Malaysia owes much to the British influence. Primary school education starts at age 6 (although there are kindergarten facilities before 6) and is free of charge but not compulsory. Secondary school education starts at age 11 and is available to all who want it. Fees have to be paid but the Government assists in cases of hardship; the vast majority of children, particularly in the urban areas, attend school regularly.

Teachers have little control over the syllabus taught in the primary or secondary schools. In 1973 the Curriculum Development Centre was set up and this makes recommendations for the syllabus in the secondary schools. Their recommendations are not automatically accepted: the decision being taken by a Central Curriculum Committee in the Ministry of Education comprised mainly of directors of the different professional divisions of the Ministry.

15.2 PUBLIC EXAMINATIONS IN MATHEMATICS

In the secondary schools various public examinations have to be taken. The first of these, at the end of the 3rd year, is known as the LCE (Lower Certificate of Education) or SRP. About 50 per cent of the pupils proceed beyond this stage and a pass in mathematics is essential. (About 60 per cent pass the LCE mathematics examination). Beyond the 3rd year most of the pupils stay in the ordinary state schools but a minority can proceed to technical schools and these are felt by some to offer a higher level of education.

At the end of the 5th year pupils take the MCE examination (Malaysian Certificate of Education), to be redesignated SPM in line with the Government's Bhasa Malaysia Policy (that education should be in the Malay language). The syllabuses in mathematics for the MCE follow the pattern of the Cambridge University Local Examinations Syndicate 'O' levels with minor modifications on advice from the Mathematics Department of the University of Malaya. The papers were set in the UK and marked in Malaysia on a marking scheme from the UK, but recently setting and marking have been done in Malaysia with UK moderation.

At the end of the 7th year (second year 6th form, as in UK) pupils take the HSC (Higher Schools Certificate, which is again based on the Cambridge University Local Examinations Syndicate 'A' levels). These examinations are

still set in the UK and marked in Malaysia on a UK marking scheme, but this too is in the process of change to greater Malaysian control with the setting up of the Malaysian Examinations Council.

15.3 SYLLABUSES IN MATHEMATICS

Until recently, the MCE syllabus was in the 'traditional' mould and followed closely the CULES 'Alternative Syllabus B'. Teaching material was drawn from a variety of sources including the books of the Scottish Mathematics Group and, particularly in years 4 and 5, some of the SMP (Schools Mathematics Project, UK) work.

In 1970 the Government decided to embark on a phased implementation of 'modern mathematics' and transfer from the 'traditional' syllabus will be completed by about 1983. The new 'modern mathematics' syllabus for year 1 to 5 is outlined in a discussion paper produced by the Curriculum Development Centre of the Malaysian Ministry of Education, and presented in part as Appendix I. Only general aims, basic approach, and illustrative selected syllabus contents at different levels are presented. The MCE examination will be that of the CULES Syllabus C. (See Appendix II). Thus the mathematics programme up to year 5 will still contain a large amount of traditional manipulative work.

In the 5th form some pupils can also take 'Additional Mathematics'. This is a mixture of 'traditional' and 'modern' work so that those who have transferred to the modern syllabus are temporarily at an advantage. All those who go on to the Science 6th form (about 25 per cent) will have studied Additional Mathematics. (See Appendix III).

In the 6th form mathematics is optional. Of those who study mathematics about two-thirds take one principal subject ('A' level) which is either CULES Mathematics Syllabus A (Traditional), Mathematics Syllabus B (Modern) or Statistics. However it would seem that about 99 per cent choose the first option. The remaining one-third take two principal mathematics courses: either

Pure Mathematics (Traditional) + Applied Mathematics (Traditional)

or

Mathematics Syllabus B + Further Mathematics

or

Mathematics Syllabus A or B + Statistics.

In practice however about 99 per cent choose the first pair of subjects.

To cope with the Bhasa Malaysia Policy a programme of work is underway to translate into the Malay language relevant text-books and teaching material. In particular the Curriculum Development Centre of the Malaysian Ministry of Education are preparing a 'source book' for teachers.* This includes a

* Produced on behalf of the Curriculum Development Centre by Bewan Behasa.dau Pustaka.

section on statistics of about 15 pages. (A translated resumé is presented as Appendix IV).

15.4 STATISTICS IN MALAYSIAN SCHOOLS

The MCE ('O' level) examination syllabuses contain a reasonable amount of statistical material, particularly the Additional Mathematics syllabus. This is in the rather formal mould familiar to UK 'O' and 'A' level syllabuses until a few years ago with the emphasis on descriptive statistics and simple probability calculations. In a recent survey of teachers on in-service courses, statistics figures prominently under the heading of what the teachers found 'difficult to teach'. It may not be surprising therefore that in practice the optional statistics material of the Additional Mathematics syllabus is omitted, and even the smaller component of statistical material in Mathematics Syllabus C is largely ignored. Whilst in the 6th form it is possible to study statistics (in the UK 'A' level mould) in some detail, this is again almost never undertaken (see § 15.3 above).

15.5 SUMMARY

Mathematics taught in Malaysian schools follows the pattern of the UK 'O' and 'A' level syllabuses. Specifically, up to 5th year Mathematics Syllabus C of the CULES is used but some pupils also take the Additional Mathematics syllabus. Whilst the material of Syllabus C is in the modern mould it is by no means extreme of this type. In spite of the modern flavour of the Mathematics Syllabus which is used to the 5th year most of the pupils in the 6th form take traditional mathematics, either Mathematics Syllabus A alone or, as two subjects, Pure Mathematics and Applied Mathematics. Up to year 5 very little statistics is taught. It is feasible for 6th form pupils to study statistics as a full subject (on the CULES syllabus) but virtually unknown for them to do so in practice.

APPENDIX I *Modern Mathematics Syllabus for Secondary Schools (Forms I–V)*

GENERAL AIMS OF THE SYLLABUS

1. Pupils should be able to:
   (i)   understand basic mathematical concepts of number and shape and to apply these to real situations;
   (ii) express themselves clearly, logically and concisely, using mathematical symbols wherever appropriate;
   (iii) make observations, discover patterns and relationships, draw conclusions, build concepts and make generalisations;
   (iv) describe a physical situation in a mathematical form;
   (v)   gain an aesthetic appreciation of and a lasting interest in mathematics; and
   (vi) acquire knowledge, skills and techniques useful in the study of other subjects as well as for future vocations.

2. The syllabus aims to provide:
   (i) a useful experience of mathematics for those who do not pursue the subject beyond SRP level; and
   (ii) an adequate foundation for mathematics at higher level.

APPROACH TO THE STUDY OF MATHEMATICS

1. Mathematics should be taught as an integrated whole and various facts or topics should be interrelated with each other to show the underlying structure and power of Mathematics.
2. The approach to new concepts and techniques should be through situations which are real, meaningful and relevant to pupils. Practical work by pupils and demonstrations by the teacher make for more effective understanding.
3. Pupils should be encouraged whenever possible to carry out their own investigations to discover for themselves techniques and results. Though the acquisition of manipulative skills is important, emphasis should be placed on a real understanding of mathematical concepts and processes.
4. In order to foster in the pupils a liking for and a lasting interest in Mathematics, the learning of Mathematics should be made into an enjoyable and challenging experience as far as possbile.

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MODERN MATHEMATICS SYLLABUS

FORM I

1. SETS
The idea of a set; elements, membership of a set. Sets in which the elements are either listed or described unambiguously. Equal sets. The empty or null set denoted by ϕ or { }. Universal sets, denoted by E or $\mathscr{E}$. Subsets, use of symbol $\subset$. Venn diagrams to represent relationships between sets. Intersection of 2 sets, e.g. P and Q, denoted by $P \cap Q$.

2. THE SYSTEM OF WHOLE NUMBERS
   (i)   Operations of addition and multiplication on the set of whole numbers. Subtraction as inverse operation of addition. Division as inverse operation of multiplication. Identity elements.
   (ii) Subsets of whole numbers including natural numbers, even numbers, odd numbers, prime numbers, composite numbers, squares of whole numbers and cubes of whole numbers.
   (iii) Sequences – developing sequences and identifying terms in a sequence.
   (iv) Tests of divisibility, in particular by 2, 3, 4, 5 and 10.
   (v)   Multiples, factors and prime factors. LCM from the intersection of the sets of multiples. HCF from the intersection of the sets of factors. Both LCM and HCF to involve numbers less than 100.

3. LAW OF ARITHMETICAL PROCESSES RESTRICTED TO THE SET OF WHOLE NUMBERS
   (i)   General idea of commutative and associate laws.
   (ii) The commutative and associative laws for addition and multiplication.
   (iii) The distributive law of multiplication over addition.
   (iv) The idea of a binary operation: $+, -, \times, \div$, 'star', 'circle', etc., according to some given definition. Use of these operations to verify the above laws. Operation tables – row, column, main diagonal.

4. FRACTIONS, RATIOS AND PERCENTAGES
   (i)   The meaning of fractions including terminology of numerator and denominator. Comparing fractions ($>$ and $<$).
   (ii) Equivalent fractions, proper and improper fractions and mixed numbers.
   (iii) From whole numbers to fractions by using number line. Finding other fractions between two given fractions.

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17. STATISTICS
Collection of data; illustrating data by pictographs, bar charts, pie charts and line graphs; information obtained by interpolation and extrapolation from given graphs.

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FORM II

18. FURTHER SETS
   (i) Finite and infinite sets. Number of elements in a set, denoted by $n(A)$ for set A.

(ii) Properties of equal sets
   (a) $n(X) = n(Y) \Rightarrow X = Y$ or $X \neq Y$.
   (b) $X = Y \Rightarrow n(X) = n(Y)$.
(iii) Set-builder notation, denoted by $\{x : x$ satisfies a given condition$\}$.
(iv) Listing of subsets of a given set; relationship between elements of a set and total number of subsets.
(v) Intersection of sets, commutative and associate laws.
(vi) Union of two sets, denoted by $A \cup B$ for sets A and B.
(vii) Complement of a set, denoted by P' for set P.
(viii) Venn diagrams for union and complement of sets.

19. *OPERATIONS ON INTEGERS*
(i) Operations of subtraction, multiplication and division; commutative, associative and distributive laws, operation tables; number patterns and sequences.
(ii) Squares, cubes, etc. of negative integers.

20. *RATIONAL NUMBER SYSTEM*
(i) Equivalent fractions, e.g. $\frac{5}{1} - \frac{3}{1} = 5 - 3$ and $\frac{0}{-3} = \frac{0}{4} = 0$.
(ii) Order $(>, <, =, >, <)$.
(iii) Additive inverse and multiplicative inverse (reciprocal).
(iv) Identity elements of addition and multiplication.

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38. *STATISTICS*
(i) Measurement, samples and populations.
(ii) Representation of discrete quantities by frequency tables.
(iii) Discrete tables using class intervals.
(iv) Frequency distributions illustrated as frequency polygons.
(v) Frequency distributions illustrated by histograms; choice of class intervals.
(vi) Calculation of the mean (formerly referred to as average) from a frequency table not involving class intervals.

FORM III

39. *NUMBER SYSTEMS*
(i) Counting systems to include bases 2, 10, 8 and 12.
(ii) Simple conversion of numbers in base 10 to numbers in other bases and vice-versa.
(iii) Addition and subtraction of numbers in base 8 and base 12.

40. *SOCIAL ARITHMETIC*
   Simple problems involving:
(i) Household budget, income and expenditure.
(ii) Rates — assessment of house; quit rent.
(iii) Hire purchase.
(iv) Value of money — conversion of currency.
(v) Simple life insurance.
(vi) Tax on personal income.

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49. *STATISTICS*
(i) Extension of histograms to continuous quantities.
(ii) Mode, median and quartiles in frequency distributions.
(iii) Calculation of the mean using an assumed mean (not involving class intervals).
(iv) Cumulative frequency tables and ogive.

50. *TRIANGLES AND QUADRILATERALS*
Summary of the properties of triangles, rectangles, squares, parallelograms, rhombuses and kites involving angles, sides and diagonals. The properties may be deduced from translation (including tiling), outline fitting (reflection, rotation) and symmetry. Simple riders (numerical examples).

51. *THE CIRCLE*
Simple properties of the circle; symmetry. Tangents, including perpendicularity of tangent and radius. Angle at the centre twice angle at the circumference. Angles in the same segment.

FORM IV

52. *STANDARD FORM*
(i) Expression of numbers in standard form $A \times 10^n$ where n is a positive or negative integer, and $1 \leqslant A < 10$.
(ii) Calculations and comparisons of numbers in standard form.

53. *MEASUREMENT AND ACCURACY*
(i) Difference between counting and measuring.
(ii) Approximations and their limits of accuracy expressed in the following forms:
   (a) to the nearest multiple of a given quantity e.g. population of a town to the nearest thousand;
   (b) significant figures;
   (c) decimal places;
   (d) tolerance, use of $\pm$ notation, e.g. 10.0 ± 0.1 cm.
   (e) percentage errors.
(iii) Effect of errors on sums, differences, products and quotients e.g. perimeter, area and speed; estimate of errors.

59. *LINEAR PROGRAMMING*
(i) Formation of linear relationships of equations and inequations in two variables from given data.
(ii) Use of equations and inequations to problems of maximising or minimising a linear function.
(iii) Identification of the intersection of several linear equations and inequations.

60. *MATRICES*
(i) The matrix as a table of information; the order of a matrix; addition and subtraction of matrices. Conditions for sum and difference to exist.

    (ii)   Multiplication of matrices; multiplication of a matrix by a scalar quantity. Conditions for product to exist.

    (iii)   Special matrices: null, unit (or identity) matrices.

    (iv)   Non-commutative nature of matrix multiplication.

    (v) 2×2, 2×1 and 1×2 matrices.

    (vi)   The inverse of a 2×2 matrix; condition for the inverse to exist.

61. VECTORS

    (i)   The use of modulus sign to indicate the magnitude of a vector $|\overrightarrow{AB}|$ or $|a|$.

    (ii)   The sum or difference of vectors, and their use in expressing vectors in terms of two coplanar vectors.

    (iii)   Use of the results:

        (a) $a = b \Rightarrow |a| = |b|$, and a parallel to b

        (b) $ha = kb \Rightarrow a$ parallel to b, or $h = 0$ and $k = 0$, in proving properties of equivalence, parallelism, concurrence and collinearity.

64. STATISTICS

    (i)   Continuous variables, class intervals, histograms and calculation of the mean for grouped data.

    (ii)   Appropriateness of various methods of representing data i.e. the choice between histograms, pie-charts, bar-charts, frequency polygons, etc. in various situations.

65. PROBABILITY

    (i)   Introduction to the ideas of probability through simple experiments.

    (ii)   Equally likely outcomes.

    (iii)   Definition of probability.

    (iv)   Use of ideas of set and sub-set of possible outcomes.

    (v)   Diagrammatic solution of simple probability problems by the use of finite possibility spaces.

    (vi)   Combining events, intersection of possibility spaces.

FORM V

66. THE EARTH AS A SPHERE

    (i)   Angles of latitude and longitude, circles of latitude and longitude as sets of points.

    (ii)   Great circles, small circles, nautical miles, knots.

    (iii)   Measurement along parallels of latitude and along meridians in nautical miles.

67. TRIGONOMETRY

Use of the sine and cosine formulae for any triangle.

68. NAVIGATION

    (i)   The meaning of the terms; heading (course), drift and track.

    (ii)   Heading and track as examples of vectors.

    (iii)   Application of vectors to simple problems; solution by calculation and drawing.

69. VARIATION

    (i)   Direct and inverse variation for linear, square and cube (direct only) functions.

    (ii)   Joint variation with two or more variables.

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71. MATRICES AND TRANSFORMATIONS

    (i)   The mapping of coordinates by means of 2×2 matrix multiplication.

    (ii)   Use of 2×2 matrices to represent transformations.

    (iii)   Matrices for the elementary transformations: shear, enlargement, stretch, reflections in the axes, rotations of multiples of $90°$, reflections in $y = \pm x$. (These matrices should not be memorised.)

    (iv)   The use of the unit square and its image to obtain the matrix for a transformation.

    (v)   Combining transformations, order of operations, matrix representation, simple constructions.

72. PROBABILITY

Use of Venn diagrams and tree diagrams to solve simple problems of combinations of probabilities.

APPENDIX II   *MCE Syllabus 1978 & 1979 **

MATHEMATICS SYLLABUS C (453)
(May not be taken with 450, 451 or any Mathematical subject at
Advanced level)

ORDINARY LEVEL AND SCHOOL CERTIFICATE

Introduction
The emphasis of the examination will be on the understanding of basic mathe-matical concepts and their application, rather than on skill in performing lengthy manipulations.

Importance will be attached to clear expression and careful reasoning; knowledge of the signs $\Rightarrow, \Leftrightarrow, \Leftarrow, \neq, \leqslant, \geqslant, \simeq$ will be expected. The solidus will be used in the question papers.

Candidates should be able to express physical situations in mathematical symbols and to use their judgement as to the degree of accuracy appropriate to any particular problem.**

In Geometry questions, although familiarity with the ideas of transforma-tions below will be expected, any method of solution will be allowed.

In question papers, vectors will be printed in Clarendon Type, and their magnitudes denoted by modulus signs, e.g. AB, |AB|; a, |a|.

In their answers to questions, candidates are expected to indicate vectors in some *definite* way e.g. by an arrow or by underlining. Thus: $\overrightarrow{AB}, \vec{a}$ or $\underline{AB}$, $\underline{a}$ or $\underset{\sim}{AB} . \underset{\sim}{a}$.

Units
The decimal system will be used in all questions involving British currency.

SI units will be used in questions involving mass and measures; the use of the centimetre will continue.

The 24-hour clock will be used for quoting times of the day: for example, 3.15 a.m. will be denoted by 03 15; 3.15 p.m. by 15 15.

Candidates will be expected to be familiar with the solidus notation for the expression of compound units, e.g. 5cm/s for 5 centimetres per second, 13.6 g/cm³ for 13.6 grams per cubic centimetre.

Scheme of papers
In the examination two 2½-hour papers will be set, arranged as follows:

Paper 1 (100 marks) will be divided into two sections. Section 1 (60 marks) will contain 20 questions, to be attempted by all candidates. Section 2 (40 marks) will contain 12 questions. Full marks in Section 2 may be obtained for correct answers to 8 questions.

Paper 2 (100 marks) will be divided into two sections, the questions in Section 1 being easier than those in Section 2. Section 1 (50 marks) will contain 6 questions, and Section 2 (50 marks) will contain 6 questions. Can-

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** See the note [below] about the use of slide rules and electronic calculators.

didates will be required to answer 5 questions in Section 1 and 4 questions in Section 2.

Detailed syllabus
Problems involving mass, measures and money.

Fractions, decimals, ratio, percentage.

Whole numbers expressed in the denary, octal and binary scales and con-version between these scales. Addition and subtraction in octal and binary scales. (Notation such as 64_{10} may be used.) Simple multiplication in the binary scale.

Approximations, estimates of error, limits of accuracy, significant figures, decimal places, use of the standard form $A \times 10^n$ where n is a positive or negative integer, and $1 \leqslant A < 10$.

Length, area and volume, mensuration of the rectangle, triangle, cuboid, circle, cylinder, sphere, pyramid, cone and prism. Necessary formulae will be given for the sphere, pyramid and cone.

The notation and idea of a set; union, intersection, complement, subset, empty and universal sets. Venn diagrams and their use in simple logical problems; the number of elements in a set.

The following symbols and notation will be used:
$$\in, \cup, \cap, A', \subset, \supset, \emptyset, \mathscr{E}, n(A), \{x : x \text{ satisfies a condition}\}.$$
The use of symbols to represent numbers, sets, transformations, and opera-tions.

Equations and identities; rearrangement of formulae; simple algebraic fractions.

Simple inequalities. Simultaneous linear equations and inequalities in not more than two unknowns. Applications of equalities and inequalities to simple problems.

Factorisation of expressions of the form $ax + bx, a^2 - b^2, a^2 \pm 2ab + b^2$, $ax^2 + bx + c, xy = 0 \Leftrightarrow x = 0$ or $y = 0$; application to solution of quadratic equations.

Use of rectangular cartesian co-ordinates in two dimensions. Gradient.

Equation of a straight line in the forms $y = mx + c$ and $\frac{x}{a} + \frac{y}{b} = 1$.

Applications of equalities and inequalities to linear relationships and graphs, and their use in linear programming.

Linear, square and reciprocal relations. Graphs of $y = ax^n$ where $n = -2$, $-1, 1, 2, 3$ and simple sums of these functions. Simple, direct, inverse and joint variation.

The operations of reflection (M), rotation (R), translation (T), enlarge-ment (E), shear (H), and stretching (S) and their combinations.

If $T(a) = b$ and $M(b) = c$, we write $MT(a) = c$.

Invariants under the above transformations may be assumed. Candidates may also assume the fundamental properties of rectilinear figures but will be expected to give precise descriptions of transformations used.

Reflective and rotational symmetry.

Recognition of the transformations connecting given direct or oppositely

congruent figures, including the use of co-ordinates.

Similarity; applications including areas and volumes, scales and simple map problems.

The circle; symmetry properties.

Simple angle properties (angle at centre twice angle at circumference and simple deductions); tangent perpendicular to radius.

Locus as a set of points in two or three dimensions.

Simple constructions (which may involve intersections of loci).

2×2, 2×1, and 1×2 matrices. Matrix addition and multiplication, the null and the unit matrices.

The inverse matrix. Multiplication of a matrix by a scalar quantity.

The use of matrices to represent transformations.

The sine, cosine, and tangent ratios of acute angles. The use of trigonometrical tables. Solution of right-angled triangles, and of easy cases of triangles which can be reduced to right-angled triangles. The use of Pythagoras' theorem. Simple applications to 3-dimensional problems.

The sine and cosine ratios of angles between $0°$ and $360°$. The graphs of these functions and their applications to simple problems.

Use of the sine and cosine formulae for any triangle.

Graphical representation of numerical data by bar chart, frequency polygon, pie chart and histogram (area of rectangle representing frequency). Candidates may be expected to give reasons for the method they choose. Calculation of the mean. Estimation of the median and quartiles; interquartile range; modal class.

The gradient of graphs by drawing and the estimation of areas under graphs, e.g. by trapezium rule; applications to easy linear kinematics involving distance-time and speed-time curves, and to other rates of change.

The ability to draw, read and understand simple plans and elevations correctly positioned; the convention that 'hidden lines are broken'.

Arc length and sector area as fractions of circumference and area of circle.

The earth considered as a sphere: latitude and longitude, distances in nautical miles along parallels of latitude and along meridians, speed in knots.

Probability and simple combination of probabilities.

The equivalence of directed line segments, e.g. $\overrightarrow{OP}$, representing vectors. The sum and difference of vectors, and their use in expressing the vectors in terms of two coplanar vectors.

Use of the results

(i) $a = b \Rightarrow |a| = |b|$ and a parallel to b;

(ii) $ha = kb \Rightarrow$ a parallel to b; or $h = 0$ and $k = 0$,

in proving properties of equivalence, parallelism, and incidence in rectilinear figures.

Simple navigation: heading, drift and track. (Vector methods may be used.)

APPENDIX III   *Additional Mathematics Syllabus 1978 & 1979**

ADDITIONAL MATHEMATICS (471)
(May not be taken with 962 or any Mathematical subject at
Advanced level)

ORDINARY LEVEL AND SCHOOL CERTIFICATE

HSC (SUBSIDIARY) MATHEMATICS (979)
(May not be taken with 962)

Scheme of papers

There will be two 2½-hour papers. Each paper will be divided into Section A, Pure Mathematics (10 questions); Section B, Pure Mathematics (6 questions), Mechanics (6 questions), Statistics (6 questions), Vectors and Algebraic Structure (6 questions). Candidates will be required to answer eight questions from Section A and not more than five questions from Section B in each paper.

The units used in the examination papers will conform to the usage in other O-levels and SC Mathematical subjects.

Candidates will be provided with a list of formulae MF (Add.) 1 for use in the examination.

Detailed syllabus
Section A
Pure Mathematics

Ideas of functions and relations; cartesian graphs by sketching and accurate plotting; arrow diagrams; domain and range of a function. Composite functions. [The notations $y = f(x) = \sin x$ and $f: x \to \sin x$ will be used.]

Gradient of a straight line; relationship between gradients of perpendicular lines and of parallel lines; equation of a straight line referred to rectangular axes in a plane. Elementary two-dimensional rectangular cartesian co-ordinate geometry, e.g. distances, area of a triangle but not angles.

The meaning of $\frac{dy}{dx}$. Derivative of kx^n, where n is rational; differentiation of a sum. (Formal proofs will not be required.) Applications to small increments, rates of change, velocity and acceleration, maxima and minima (any method of discrimination will be acceptable).

The definite integral and integration as the inverse of differentiation. Integration of simple functions (excluding integration by parts and by change of variable); application to plane areas and volumes of solids and to kinematics.

Circular measure; arc length and area of a sector of a circle. Trigonometrical ratios of angles of any magnitude. Graphs of simple trigonometrical functions. The solution of triangles and determination of area (only the sine

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and cosine formulae and the formula $\frac{1}{2}bc \sin A$ will be needed; proofs will not be required). Simple trigonometrical problems in three dimensions.

Elementary permutations and combinations. Introduction to probability.

The binomial theorem for a positive integral index and its use for simple approximations. (Questions on the greatest term and on properties of the coefficients will not be asked.)

Simultaneous equations, at least one linear, in two unknowns.

Section B
Mechanics
(While formal vector notation will not be used in question papers vector methods of solution will be welcome where appropriate.)

Kinematics of a particle moving in a straight line; its graphical treatment; motion with uniform acceleration.

Composition and resolution of velocities; relative velocity.

Composition and resolution of forces; moments. (An experimental basis is sufficient; proofs of the fundamental theorems of statics will not be required.) Equilibrium of a particle and of a rigid body under coplanar forces. The laws of friction between solids in contact.

Newton's laws of motion and the ideas of force, momentum, energy, work, power. The conservation of momentum in rectilinear motion. Conservation of energy.

Statistics
(Credit will be given for the choice and use of appropriate methods and for valid deductions from results, as well as for the ability to carry out mechanical processes. Proofs will not be required.)

The tabulation and appropriate representation of numerical data; choice of class intervals.

Measures of central tendency: mean, median and mode. Percentiles. Measures of dispersion: interquartile range and standard deviation. Use of assumed mean.

Moving averages.

Index numbers.

The sum and product laws of probability. Expectation.

Discrete variable: simple probability and frequency distributions, particularly the binomial distribution and its mean and standard deviation.

General ideas of sampling and surveys. Estimation of the limits of a mean of a population from a large sample.

Scatter diagrams. General ideas of correlation. Calculation of a rank correlation coefficient (preferably Kendall's).

Pure Mathematics
Indices, logarithms and surds. Remainder and factor theorems.

Determination of a function from a straight line graph.

Elementary sequences; sum of a finite number of terms in the cases of arithmetical and geometrical progressions.

Elementary properties of quadratic equations. Range of values of the function $ax^2 + bx + c$ by graphical and other methods.

Use of formulae for $\sin (A \pm B)$, $\cos (A \pm B)$, $\tan (A \pm B)$; applications to multiple angles and simple identities.

Representation of a curve by means of a pair of parametric equations (single parameter only); equations of tangent and normal. Elementary locus problems including elimination of a parameter.

Derivatives of simple algebraic and trigonometrical functions including sums, products, quotients, composite functions (functions of a function) but excluding implicit functions and inverse trigonometrical functions.

Vectors and Algebraic Structure
(Use of the language and notation of sets, including Venn diagrams, will be expected.

In question papers, vectors will be printed in Clarendon Type, and their magnitudes denoted by modulus signs, e.g. AB, |AB|; a, |a|.

In their answers to questions, candidates are expected to indicate vectors in some *definite* way e.g. by an arrow or by underlining. Thus $\overrightarrow{AB}$, $\vec{a}$ or $\underline{AB}$, $\underline{a}$ or $\underline{AB}$, $\underline{a}$.)

Displacement and position vectors (2 dimensions); addition of vectors; multiplication of a vector by a scalar; the ratio theorem

$$\lambda OP + \mu OQ = (\lambda + \mu) OR.$$

The scalar product a.b of two vectors in the form a.b $= |a| \, |b| \cos \theta$ and also a.b $= a_1 b_1 + a_2 b_2$ where

$$a = \begin{pmatrix} a_1 \\ a_2 \end{pmatrix} \text{ and } b = \begin{pmatrix} b_1 \\ b_2 \end{pmatrix};$$

application of the scalar product to test perpendicularity in a plane.

Examples of arrays from everyday life; square and rectangular arrays; components of a position vector as elements in a 2×1 rectangular array.

Matrices as arrays obeying prescribed rules of operation; addition rule; null matrices, multiplication rule; unit matrices; pre- and post-multiplication and the non-commutative property.

The set of 2×2 matrices; the inverse of a non-singular 2×2 matrix; geometrical interpretation of conditions for non-existence of an inverse.

Application of 2×2 matrices to geometrical transformations of the plane; combination of rotations, reflections, enlargements and shears.

The ideas of a group and isomorphism; illustrations from geometric patterns, permutations, the number system and residue classes to a prime modulus (finite fields).

APPENDIX IV   *'Source Book' Resumé*

STATISTICS

1. *WHAT STATISTICS SHOULD BE TAUGHT*

Form 1 (i) Collection of data.
(ii) Illustrating data by pictographs, bar charts, and line graphs.
(iii) Information obtained by interpolation and extrapolation from given graphs.

Form 2 (i) Measurement, samples and populations.
(ii) Representation of discrete quantities by frequency tables.
(iii) Discrete tables using class intervals.
(iv) Frequency distributions illustrated as frequency polygons.
(v) Frequency distributions illustrated by histograms, choice of class intervals.
(vi) Calculation of the mean (formerly referred to as average) from a frequency table not involving class intervals.

Form 3 (i) Extension of histograms to continuous quantities.
(ii) Mode, median and quartiles in frequency distributions.
(iii) Calculation of the mean using an assumed mean (not involving class intervals).
(iv) Cumulative frequency tables and ogive.

Form 4 (i) Continuous variables, class intervals, histograms and calculation of the mean for grouped data.
(ii) Appropriateness of various methods of representing data, i.e. the choice between histograms, pie charts, bar charts, frequency polygons, etc. in various situations.

The syllabus aims to provide the student with the basic skills of statistics.

(a) *How to display:*
This is the ability to make numerical information easy to understand by use of a suitable chart or graph. Conversely, the student learns how to interpret graphs and charts.

(b) *How to calculate:*
This is the ability to summarise the numerical information, by calculating average values (mean, mode, median) and how spread out the numbers are (range).

(c) *How to simplify:*
This is the ability to handle a big collection of numbers by using a frequency table (putting like numbers together) or by grouping (putting numbers into classes).

An educated person today needs to be able to handle numbers correctly. Learning statistics should help students to gain information from collections of numbers and also to avoid being misled by the incorrect use of statistics (e.g. by advertisers).

(a) *Statistics before Form 1*
In primary school simple bar charts are commonly used. For example, the number of books belonging to child A, child B and child C may be represented as follows, each designating a certain fixed number of books (say 5).

Child A   ★ ★ ★ ★
Child B   ★ ★ ★ ★ ★
Child C   ★ ★

The 'average' of a set of numbers is used. In secondary school this is called the 'mean', as other averages also occur.

(b) *Statistics at LCE level*
Much of the mathematics needed by students in other LCE subjects is statistical. In geography, much local, national, foreign and international information is given using numbers. Weather information is given by graphs and histograms; commodity exports are given by pie charts. In science, graphs are often used to summarise or explain physical events. The mathematics class must help the student to make sense out of these numbers and graphs used in other subjects.

(c) *Statistics at MCE Elementary Mathematics level*
The MCE Elementary Mathematics Alternative C syllabus states: 'Graphical representation of numerical data by bar chart, frequency polygon, pie chart and histogram (area of rectangle representing frequency). Candidates may be expected to give reasons for the method they choose. Calculation of the mean. Estimation of the median and quartiles; interquartile range; modal class.' Thus most of the statistics needed for MCE Elementary Mathematics Alternative C Syllabus is first studied for LCE.

(d) *Statistics at MCE Additional level and HSC Subsidiary level*
'Statistics' is one of the four optional sections along with 'Pure Mathematics' Mechanics' and 'Vectors and Algebraic Structure'. It is essential to offer one of these four options and schools often teach two of them.

(e) *Statistics at HSC Principal level*
Syllabus A (840). This is the syllabus commonly used at present; for paper 2, statistics may be studied instead of or as well as mechanics. Syllabus B (848). This is the new syllabus, section A is studied by all candidates and in section B two options must be chosen from five. 'Statistics and Probability' is one of these five options.
It is obvious that whatever mathematics examinations a student sits after LCE, a good knowledge of LCE statistics will provide a useful foundation.

(f) *Statistics after LCE outside mathematics*
All science subjects and geography make increasing use of graphs, measurements, averages and statistical ways of testing theories. All government departments have to collect statistical information regularly, and the general population contributes when a census is taken. Statistics are essential to government to enable wise planning to take place. Everyone meets with statistics in the statements

and speeches of politicians and in the claims of advertisers. It is therefore essential for students to be conversant with at least basic statistics.

CHAPTER 16

Some Publications on Teaching Statistics in Japan

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It has not been possible to obtain a specially commissioned review on the teaching of statistics in Japanese schools. However, Dr. H. Midzuno of the Statistics Bureau of the Prime Minister's Office in Tokyo has kindly communicated information on some publications describing the situation in Japan. An important feature of these is that they have been translated into English. They are described briefly below and anyone wanting further details should communicate with the Editor of this Report.

1. UKITA Yoshimasa (1981) 'The existing state of teaching statistics in school education in Japan'. *Submitted* to *Journal of Japan Statistical Society*

In the *Summary* we read:

> 'Up to this date, we have no independent curriculum of teaching statistics in school education in Japan: In elementary, middle and high schools it has been taught in diverse courses of mathematics, civics and natural sciences, and in colleges and universities various departments such as mathematics, information sciences, industrial administration, management, or economics, have had their own curriculum for teaching statistics. In this article, the author presents a brief report on the situation of teaching statistics in school education in our country.'

2. ITO Koichi (1980) 'The Teaching of Statistics in Japanese Universities and Colleges' (Abstract) 48th Session, Japan Statistical Society.
This briefly describes contributions by three speakers: Ukita, Y., on a theme similar to that described in 1. above; Kudo, A., on differences in the teaching of mathematical statistics in mathematics departments and in other departments of natural science and technology; Okamoto, T., on a survey of 14 Japanese universities which have doctoral programmes in mathematical statistics (the interest is in training research workers and teachers of statistics). N.B. 'no Japanese universities and colleges have an independent department or unit of statistics, which is a formidable obstacle to improvement of statistics teaching in Japan.'

3. INTERNATIONAL ROUNDTABLE CONGRESS – 50th Anniversary of the Japan Statistical Society (1981)
This is an interesting series of brief notes and abstracts by the organiser