Government of **Western Australia**
**School Curriculum and Standards Authority**

# DRAFT FOR CONSULTATION

# MATHEMATICS APPLICATIONS

ATAR course

**Year 12 syllabus for teaching from 2029**

**Acknowledgement of Country**

Kaya. The School Curriculum and Standards Authority (the Authority) acknowledges that our offices are on Whadjuk Noongar boodjar and that we deliver our services on the country of many traditional custodians and language groups throughout Western Australia. The Authority acknowledges the traditional custodians throughout Western Australia and their continuing connection to land, waters and community. We offer our respect to Elders past and present.



**Important information**

This syllabus is effective from 1 January 2029.

Users of this syllabus are responsible for checking its currency.

Syllabuses are formally reviewed by the School Curriculum and Standards Authority (the Authority) on a cyclical basis, typically every five years.

# Contents

# Rationale

The Mathematics Applications ATAR course is the study of mathematical concepts and techniques used to analyse, interpret and solve real-world problems. It focuses on applying mathematical concepts to help students make informed choices, including financial and statistics-based decisions, in personal and professional settings.

The course also focuses on solving practical problems that involve financial modelling, trigonometry, statistical analysis of bivariate and time series data, real-world growth and decay using sequences, and network graph models with an emphasis on efficient and appropriate use of digital tools.

By studying this course, students develop fluency in calculations, analytical reasoning and the ability to interpret and communicate mathematical ideas effectively. The course encourages logical thinking, attention to detail, and the ability to evaluate information critically, fostering a deeper understanding of the role mathematics plays in everyday decision-making.

The mathematical skills and concepts covered in the course have broad application in daily life. Students learn to manage personal investments, use concepts of trigonometry to solve practical problems and model and analyse growth and trends using statistical data to make informed predictions in practical scenarios. Students apply graph theory techniques to solve real-world problems such as finding optimal routes and optimising resource allocation in various situations.

The Mathematics Applications ATAR course provides a strong foundation for students intending to pursue tertiary education or vocational training in business, finance, social sciences, health sciences, information technology and environmental studies. Careers in areas such as economics, data analysis, logistics, project management, public administration and education all benefit from the skills developed in this course.

# Aims

The Mathematics Applications ATAR course aims to develop students':

- understanding of concepts and techniques drawn from number and algebra, geometry and trigonometry, graphs and networks, and statistics
- ability to apply mathematical knowledge to solve real-world problems
- proficiency in reasoning and interpretation within mathematical and statistical contexts
- capacity to communicate findings clearly and systematically, using precise and appropriate mathematical and statistical language
- confidence to select and use digital tools appropriately and efficiently to support problem-solving and data analysis.

# Organisation

This course is organised into a Year 11 syllabus and a Year 12 syllabus. The cognitive complexity of the syllabus content increases from Year 11 to Year 12.

## Structure of the syllabus

The Year 12 syllabus is divided into two units which are delivered as a pair. The notional time for the pair of units is 110 class contact hours.

## Organisation of content

### Unit 3

Contains four topics:

- Bivariate data analysis
- Growth and decay in sequences
- Pythagoras and trigonometry in two-dimensions
- Graphs and networks in action.

### Unit 4

Contains three topics:

- Time series analysis
- Loans and investments
- Decision mathematics.

Each unit includes:

- a unit description – a short description of the focus of the unit
- learning outcomes – a set of statements describing the learning expected as a result of studying the unit
- unit content – the content to be taught and learned.

### Role of technology

It is assumed that students will be taught this course with an extensive range of technological applications and techniques. These technologies have the potential to enhance the teaching and learning of mathematics; however, students also need to continue to develop skills that do not depend on technology. The ability to choose when and when not to use some form of technology, and the ability to work flexibly with technology, are important skills in this course.

## Representation of the General Capabilities

The General Capabilities encompass the knowledge, skills, behaviours and dispositions that will support students to live and work successfully now and into the future. They are not assessed unless identified within the specified unit content. Teachers should find opportunities to incorporate the following General Capabilities into the teaching and learning program for the Mathematics Applications ATAR course.

## Critical and creative thinking

Students identify and clarify information from a range of sources, including visual information and digital sources. They identify the relevant aspects of a concept or problem, understanding that a single mathematical process can be used in seemingly different situations and that approaches may change depending on the context or nature of the problem. Students draw conclusions and make choices when completing tasks by connecting evidence from within and across the mathematical content to provide reasons and evaluate arguments for choices made.

## Digital literacy

Students use appropriate digital tools to support the development of mathematical understanding and to apply mathematical knowledge to a range of problems. They use technologies aligned with areas of work they may be involved with such as statistical analysis, computation of algorithms, manipulation of data and expressions, and complex calculations. Students use digital tools to make connections between mathematical theory, practice and application.

## Literacy

Students develop literacy skills and strategies that enable them to express, interpret and communicate complex mathematical information, ideas and processes. Mathematics provides a specific and rich context for students to develop their ability to read, write, visualise and talk about complex situations involving a range of mathematical ideas. They apply and further develop their literacy skills and strategies by shifting between verbal, graphical, numerical and symbolic forms of representing problems to formulate, understand and solve problems and communicate results. Students learn to communicate their findings in different ways, using multiple systems of representation to illustrate the relationships they have observed or constructed.

## Numeracy

Students develop their numeracy skills at a more sophisticated level, making decisions about the relevant mathematics to use, following through with calculations, selecting appropriate methods and being confident of their results. This course contains topics that will equip students for the increasing demands of the information age, developing the skills of critical evaluation of numerical information in its various forms of collection and presentation. They will enhance their numerical operation skills via engagement with financial mathematics, number sequences, modelling and analysis of practical situations involving networks, and the statistical analysis of data.

## Addressing the other General Capabilities

Although the following General Capabilities have not been identified as a focus in the Mathematics Applications ATAR Year 12 syllabus, teachers may find opportunities to incorporate them into the teaching and learning program.

- Ethical understanding
- Intercultural understanding
- Personal and social capability

Such opportunities may occur through the application of different contexts, pedagogical practices and/or assessment strategies that relate to the syllabus as part of the teaching and learning program.

## Summary representation of the General Capabilities in the Mathematics Applications ATAR course

The unit content and assessment types for this course provide students with the opportunity to develop the General Capabilities summarised in the table below.

| Year | Course | Course type | General Capabilities | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | CCT | DL | EU | IU | L | N | PSC |
| Year 11 | Mathematics Applications (AEMAA) | ATAR | ✓ | ✓ | | | ✓ | ✓ | |
| Year 12 | Mathematics Applications (ATMAA) | ATAR | ✓ | ✓ | | | ✓ | ✓ | |

**Key**
CCT: Critical and creative thinking, DL: Digital literacy, EU: Ethical understanding, IU: Intercultural understanding, L: Literacy, N: Numeracy, PSC: Personal and social capability

# Representation of the Cross-curriculum Priorities

The Cross-curriculum Priorities address the contemporary issues that students face in a globalised world. Teachers may find opportunities to incorporate them into the teaching and learning program for the Mathematics Applications ATAR course. The Cross-curriculum Priorities are not assessed unless they are identified within the specified unit content.

## Aboriginal and Torres Strait Islander histories and cultures

Mathematics courses value the histories, cultures, traditions and languages of Aboriginal and Torres Strait Islander peoples and their past and ongoing contributions to contemporary Australian society and culture. Through the study of mathematics within relevant contexts, students develop an understanding and appreciation of the diversity of Aboriginal and Torres Strait Islander peoples' histories and cultures.

## Asia and Australia's engagement with Asia

There are strong social, cultural and economic reasons for Australian students to engage with the countries of Asia and with the past and ongoing contributions made by the peoples of Asia in Australia. It is through the study of mathematics in an Asian context that students engage with Australia's place in the region. By analysing relevant data, students further develop an understanding of the diverse nature of Asia's environments and traditional and contemporary cultures.

## Sustainability

Each of the mathematics courses provides students with the opportunity to develop informed and reasoned points of view, discuss issues, research and problem-solve. Teachers are therefore encouraged to select contexts for discussion that are connected with sustainability. Through the analysis of data, students have the opportunity to research and discuss sustainability and learn the importance of respecting and valuing a wide range of world perspectives.

# Unit 3

## Unit description

This unit has four topics:

- Bivariate data analysis extends students' understanding of associations between pairs of variables to include quantitative methods for identifying, analysing and describing the relationships, including modelling and evaluating linear associations. The content is to be taught within the framework of the statistical investigation process.
- Growth and decay in sequences employs recursion to generate sequences that can be used to model and investigate patterns of growth and decay in a wide range of practical situations, including radioactive decay, the spread of a virus or the change in an animal population with migration. Sequences are also essential to understanding the patterns of growth and decay in loans and investments that are studied in Unit 4.
- Pythagoras and trigonometry extends students' knowledge of trigonometry to solve practical problems involving non-right-angled triangles in two dimensions including problems involving the use of bearings in navigation.
- Graphs and networks in action introduces weighted graphs to model real-world situations and the use of algorithms to solve optimisation problems involving paths and connections.

Classroom access to the technology necessary to support the computational, graphical and statistical aspects of this unit is assumed.

## Learning outcomes

By the end of this unit, students:

- demonstrate the concepts and techniques used in bivariate data analysis, growth and decay in sequences, Pythagoras and trigonometry in two dimensions, and graphs and networks in action
- apply reasoning skills and solve practical problems in bivariate data analysis, growth and decay in sequences, Pythagoras and trigonometry in two dimensions, and graphs and networks in action
- implement the statistical investigation process in contexts requiring the analysis of bivariate data
- communicate their arguments and strategies when solving mathematical and statistical problems, using appropriate mathematical or statistical language
- interpret mathematical and statistical information, ascertain the reasonableness of their solutions to problems and answers to statistical questions
- choose and use technology appropriately and efficiently.

## Unit content

An understanding of the Year 11 content is assumed knowledge for students in Year 12. It is recommended that students studying Unit 3 and Unit 4 have completed Unit 1 and Unit 2.

This unit includes the knowledge, understandings and skills described below. This is the examinable content.

### Topic 3.1: Bivariate data analysis

**Associations between categorical variables**

3.1.1 choose and construct an appropriate row- or column-based two-way relative frequency table to show proportions or percentages of authentic data for groups of different sizes

3.1.2 construct stacked percentage graphs from two-way relative frequency tables that display data from authentic, real-world contexts

3.1.3 identify and describe associations between two categorical variables and respond to claims or inferences, within the context of the situation, using evidence from a two-way relative frequency table or stacked percentage graph

**Associations between numerical variables**

3.1.4 use authentic data and digital tools to construct scatterplots, and identify and describe associations in terms of direction (positive/negative), form (linear/non-linear) and strength (strong/moderate/weak)

3.1.5 calculate the correlation coefficient ($r$) using digital tools, and interpret the value to quantify the strength and direction of a linear association in authentic data, including the effect of outliers

3.1.6 calculate and use the coefficient of determination ($r^2$) to explain the proportion of variation in a response variable that can be explained by the variation in the explanatory variable and the proportion that can be attributed to other factors, in the context of the data

3.1.7 use digital tools to determine a least-squares regression line that models the change in the response variable based on the change in the explanatory variable for authentic data

3.1.8 interpret the vertical intercept and gradient of the least-squares regression line in the context of the data and identify the effect of removing outliers

3.1.9 use the least-squares regression line to predict the value of a response variable based on the explanatory variable

3.1.10 determine residuals and plot the values to visually assess and comment on the appropriateness of fitting a linear model to the data

3.1.11 comment on the validity of a prediction based on the appropriateness of the linear model, interpolation versus extrapolation, number of data points, the proportion of variation and the context of the situation

3.1.12 identify and comment on the danger of assumed associations in the context of the variables and explain possible non-causal links

## Topic 3.2: Growth and decay in sequences

3.2.1 use arithmetic sequences to model, analyse and make predictions for real-world situations involving linear growth or decay, including:
- using a general or a recursive rule to generate an arithmetic sequence
- displaying the terms of an arithmetic sequence in both tabular and graphical form
- deducing a general or a recursive rule
- determining the sum for a given number of terms

3.2.2 use geometric sequences to model, analyse and make predictions for real-world situations involving exponential growth or decay, including:
- using a general or a recursive rule to generate a geometric sequence
- displaying the terms of a geometric sequence in both tabular and graphical form
- deducing a general or a recursive rule
- determining the sum for a given number of terms
- identifying when a sequence is converging
- determining the sum of infinite terms for a converging sequence and interpreting it in the context of the situation

3.2.3 use first-order linear recurrence relations to model, analyse and make predictions for real-world situations involving growth or decay, including:
- using a first-order linear recurrence relation to generate a sequence of terms
- displaying the terms of a first-order linear recurrence relation in both tabular and graphical form
- deducing a recursive rule
- identifying when a first-order linear recurrence relation has long-term increasing or decreasing behaviour or produces a steady-state solution
- determining a steady-state solution and interpreting it in the context of the situation

## Topic 3.3: Pythagoras and trigonometry in two dimensions

3.3.1 solve authentic problems involving triangles in two dimensions, including problems involving bearings, by choosing and applying trigonometric ratios and Pythagoras' theorem

3.3.2 choose and use the Sine Area rule or Heron's formula to solve practical problems involving the area of a non-right-angled triangle

3.3.3 choose and use the Sine rule (ambiguous case excluded) or Cosine rule to solve practical problems involving non-right-angled triangles

## Topic 3.4: Graphs and networks in action

3.4.1 construct a weighted graph (network) where edges represent quantitative values such as cost, distance, time and solve associated problems

3.4.2 solve real-world problems that require finding the shortest path between two vertices in a weighted graph using trial and error or systematic methods such as Dijkstra's algorithm

3.4.3 solve real-world problems by determining the minimum spanning tree of a connected graph using inspection or a greedy algorithm, such as Prim's or Kruskal's

# Unit 4

## Unit description

This unit has three topics:

- Time series analysis continues students' study of statistics by introducing them to the concepts and techniques of time series analysis. The content is to be taught within the framework of the statistical investigation process.
- Loans and investments aims to provide students with sufficient knowledge of financial mathematics to solve practical problems associated with taking out or refinancing a mortgage and making investments.
- Decision mathematics uses networks and graphs to model project schedules, allocate resources and assign tasks to optimise efficiency and costs in practical situations.

Classroom access to the technology necessary to support the computational, graphical and statistical aspects of this unit is assumed.

## Learning outcomes

By the end of this unit, students:

- demonstrate the concepts and techniques used in time series analysis, loans and investments, and decision mathematics
- apply reasoning skills and solve practical problems in time series analysis, loans and investments, and decision mathematics
- implement the statistical investigation process in contexts requiring the analysis of time series data
- communicate their arguments and strategies when solving mathematical and statistical problems using appropriate mathematical or statistical language
- interpret mathematical and statistical information
- evaluate the reasonableness of their solutions to problems and their answers to questions
- choose and use technology appropriately and efficiently.

## Unit content

This unit builds on the content covered in Unit 3.

This unit includes the knowledge, understandings and skills described below. This is the examinable content.

### Topic 4.1: Time series analysis

**Describing patterns in time series data**

4.1.1 construct time series plots to represent authentic data and describe features such as long-term increase or decrease (trend), length of cycles, repeated patterns in a time interval (seasonality) and any irregular fluctuations or outliers

**Analysing and interpreting time series data**

4.1.2 calculate simple moving averages (mean) and fit a least-squares regression line using time and moving averages to smooth out fluctuations and model long-term trends in real-world data

4.1.3 calculate seasonal indices for authentic time series data using the average percentage method and interpret each seasonal index to describe seasonality

4.1.4 deseasonalise (seasonally adjust) authentic time series data using the seasonal index and fit a least-squares regression line using time and deseasonalised data to forecast future values (making seasonal adjustments for periodic data)

## Topic 4.2: Loans and investments

4.2.1 calculate the effective annual rate of interest and use the results to compare investment returns and cost of loans when interest is paid or charged in compounding periods shorter than a year

4.2.2 use a recurrence relation to model a compound interest loan (with and without periodic repayments) and solve practical problems involving the effect of varying interest rates, the number of compounding periods and repayments on the future value of the loan and time taken to repay the loan

4.2.3 use a recurrence relation to model a compound interest investment (with and without periodic payments) and solve practical problems involving the effect of varying interest rates, the number of compounding periods and periodic payments on the future value of the investment

4.2.4 use a recurrence relation to model an annuity and solve practical problems involving the effect of varying the amount invested, interest rates and periodic payments on the duration of the annuity

4.2.5 use computer-based financial software or a financial calculator to determine variables such as principal, interest rate, number of instalments, compounding period, payments, remaining balance and total interest paid to solve real-world problems involving a compound interest loan or investment (including annuities and perpetuities)

## Topic 4.3: Decision mathematics

**Linear programming**

4.3.1 formulate linear inequalities to represent the restrictions on variables for a real-world problem and graph the inequalities on the Cartesian plane to identify the region for which a feasible combination of values exists

4.3.2 determine an objective function that represents the outcome to be optimised in a real-world situation involving two variables

4.3.3 identify the vertices of the feasible region and use the objective function to identify the optimal value (minimum or maximum) for a real-world problem and the conditions for which it occurs

### Project planning and critical path analysis

4.3.4 represent a real-world project by constructing a network to show interdependencies between tasks and their durations, including dummy links

4.3.5 use forward and backward scanning to calculate the earliest and latest starting time for each task, and use these times to determine the critical path for the real-world project

4.3.6 use the critical path to determine the minimum project completion time and calculate float times for non-critical activities

### Flow networks

4.3.7 solve real-world problems where a directed graph is used to represent the flow through key points from source/s to sink/s

4.3.8 construct a Flow network to represent the maximum capacity of each edge in the solution to a real-world problem

### Assignment problems

4.3.9 represent a real-world problem using a bipartite graph and solve related assignment problems

4.3.10 represent a real-world assignment problem using a square or non-square matrix and apply the Hungarian algorithm to determine and interpret the optimal solution/s (minimum or maximum) in the context of the situation

# Assessment

Assessment is an integral part of teaching and learning that in the senior secondary years:

- provides evidence of student achievement
- identifies opportunities for further learning
- connects to the standards described for the course
- contributes to the recognition of student achievement.

Assessment for learning (formative) and assessment of learning (summative) enable teachers to gather evidence to support students and make judgements about student achievement. These are not necessarily discrete approaches and may be used individually or together, and formally or informally.

Formative assessment involves a range of informal and formal assessment procedures used by teachers during the learning process to improve student achievement and to guide teaching and learning activities. It often involves qualitative feedback (rather than scores) for both students and teachers, which focuses on the details of specific knowledge and skills that are being learned.

Summative assessment involves assessment procedures that aim to determine students' learning at a particular time; for example, when reporting against the standards or after completion of a unit or units. These assessments should be limited to eight or less and made clear to students through the assessment outline.

Appropriate assessment of student work in this course is underpinned by reference to a set of predetermined course standards. These standards describe the level of achievement required to achieve each grade from A to E. Teachers use these standards to determine how well a student has demonstrated their learning.

Where relevant, higher order cognitive skills (e.g. application, analysis, synthesis and evaluation) and the General Capabilities should be included in the assessment of student achievement in this course. All assessment should be consistent with the requirements identified in the course assessment table.

Assessment should not generate workload or stress that, under fair and reasonable circumstances, would unduly diminish the performance of students.

## School-based assessment

The *Western Australian Certificate of Education (WACE) Manual* contains essential information on principles, policies and procedures for school-based assessment that must be read in conjunction with this syllabus.

School-based assessment involves teachers gathering, describing and quantifying information about student achievement.

Teachers design school-based assessment tasks to meet the needs of students. As outlined in the *WACE Manual*, school-based assessment of student achievement in this course must be based on the Principles of Assessment:

- Assessment is an integral part of teaching and learning.
- Assessment should be educative.
- Assessment must be fair.
- Assessment should be designed to meet its specific purpose/s.
- Assessment should lead to informative reporting.
- Assessment should lead to school-wide evaluation processes.
- Assessment should provide significant data for improvement of teaching practices.

The table below provides details of the assessment types and their weighting for the Mathematics Applications ATAR Year 12 syllabus.

Summative assessments in this course must:

- be limited to eight tasks or less
- allow for the assessment of each assessment type at least once over the year/pair of units
- have a minimum value of five per cent of the total school assessment mark
- provide a representative sampling of the syllabus content.

Assessment tasks not administered under test or controlled conditions require appropriate authentication processes.

## Assessment table – Year 12

| Type of assessment | Weighting |
|---|---|
| **Response**<br>Students apply mathematical knowledge and understanding of concepts and relationships to solve a mix of routine and non-routine questions in practical contexts. Response tasks can include tests, assignments and multimedia representations. | 40% |
| **Modelling task**<br>Students use a mathematical thinking process to interpret and solve an extended practical problem. The problem originates with a real-world scenario that can be turned into a mathematical problem for which the mathematics of the syllabus can be applied. The task enables students to analyse the situation, choose the mathematics required to investigate the problem and evaluate and critically interpret the scenario in context. They make and state assumptions relevant to the problem and consider the validity of the assumptions and the appropriateness of the result in presenting their findings.<br>Evidence can include observation and interview, written work or multimedia presentations. | 10% |
| **Statistical investigation**<br>Students use a statistical investigation process and syllabus-related mathematics to investigate and analyse a real-world situation. A statistical investigation involves the collection and processing of primary or secondary data to analyse then formulate conclusions in response to one or more questions that can be answered with evidence from data. The statistical investigation enables students to choose the mathematics required to collect, organise, summarise, display, analyse, evaluate and critically interpret data to develop evidence-based conclusions. They make and state assumptions relevant to the problem to support the aspects of complexity within their investigation.<br>Evidence can include observation and interview, written work or multimedia presentations. | 10% |
| **Examination**<br>Students apply mathematical knowledge, understanding and skills to analyse, interpret and respond to questions and situations in practical contexts. Examinations provide for the assessment of conceptual understandings, knowledge of mathematical terminology and techniques and students' ability to reason, interpret and apply this knowledge in a range of contexts. Examination questions can range from those of a routine nature, assessing lower-level concepts, through to those that require responses at the highest level of conceptual thinking. Examinations are typically conducted at the end of each semester and/or unit and reflect the examination design brief for this syllabus. | 40% |

Teachers are required to use the assessment table to develop an assessment outline for the pair of units.

The assessment outline must:

- include a set of assessment tasks
- include a general description of each task
- indicate the unit content to be assessed
- indicate a weighting for each task and each assessment type
- include the approximate timing of each task; for example, the week the task is conducted or the issue and submission dates for an extended task.

## Reporting

Schools report student achievement, underpinned by a set of predetermined standards, using the following grades:

| Grade | Interpretation |
|---|---|
| A | Excellent achievement |
| B | High achievement |
| C | Satisfactory achievement |
| D | Limited achievement |
| E | Very low achievement |

The grade descriptions for the Mathematics Applications ATAR Year 12 syllabus are provided in Appendix 1. They are used to support the allocation of grades. They can also be accessed, together with annotated work samples, on the course page of the Authority website (www.scsa.wa.edu.au).

To be assigned a grade, a student must have had the opportunity to complete the education program, including the assessment program (unless the school accepts that there are exceptional and justifiable circumstances).

Refer to the *WACE Manual* for further information about the use of a ranked list in the process of assigning grades.

The grade is determined by reference to the standard, not allocated on the basis of a predetermined range of marks (cut-offs).

# ATAR course examination

All students enrolled in the Mathematics Applications ATAR Year 12 course are required to sit the ATAR course examination. The examination is based on a representative sampling of the content for Unit 3 and Unit 4. Details of the ATAR course examination are prescribed in the examination design brief on the following page.

Refer to the *WACE Manual* for further information.

## Examination design brief – Year 12

This examination consists of one section.

**Time allowed**

| | |
|---|---|
| Reading time before commencing work: | ten minutes |
| Working time for paper: | one hundred and fifty minutes |

**Permissible items**

| | |
|---|---|
| Standard items: | pens (blue/black preferred), pencils (including coloured), sharpener, correction tape/fluid, eraser, ruler, highlighters |
| Special items: | drawing instruments, templates, notes on two unfolded sheets of A4 paper, and up to three calculators, which can include scientific, graphic and Computer Algebra System (CAS) calculators, are permitted in this ATAR course examination |

**Provided by the supervisor**

Formula sheet

**Additional information**

It is assumed that candidates sitting this examination have a calculator with CAS capabilities. The candidate is required to demonstrate knowledge of mathematical techniques, conceptual understandings, reasoning, use and knowledge of notation and terminology, and problem-solving skills in a range of practical contexts.

Questions can require the candidate to solve problems, investigate mathematical relationships, apply reasoning and skills, interpret results and communicate their strategies to justify mathematical results. Examination questions can range from those of a routine nature, assessing lower-level concepts, through to those that require responses to the highest level of conceptual thinking.

Instructions to candidates indicate that, for any question or part question worth more than two marks, valid working or justification is required to receive full marks.

| Section | Supporting information |
|---|---|
| **Part A: Practical problems**<br>35% of the total examination<br><br>5–10 short answer questions<br><br>Suggested working time: 50 minutes | The candidate is required to answer all Part A and Part B questions.<br><br>**Part A** questions require the candidate to solve practical problems involving application of concepts and techniques, interpreting data or explaining results.<br><br>The candidate can be required to provide answers that may include calculations, tables, graphs, interpretation of data, descriptions and/or conclusions.<br><br>Stimulus material can include diagrams, tables, graphs, drawings, print text and/or data gathered from the media. |
| **Part B: Extended application problems**<br>65% of the total examination<br><br>8–13 extended answer questions<br><br>Suggested working time: 100 minutes | **Part B** questions require the candidate to use understanding of mathematical relationships and apply concepts and techniques to solve extended application problems in a range of contexts.<br><br>The candidate can be required to apply reasoning skills, make connections between concepts, interpret results and communicate their strategies to justify solutions in context.<br><br>Questions can be from unfamiliar situations, have multiple steps and parts that will typically increase in complexity.<br><br>The candidate can be required to provide answers that may include calculations, tables, graphs, interpretation of data, descriptions and/or conclusions.<br><br>Stimulus material can include diagrams, tables, graphs, drawings, print text and/or data gathered from the media. |

# Appendix 1 – Grade descriptions Year 12*

| | |
|---|---|
| A | **Identifies and organises relevant information**<br>Identifies and organises relevant information for complex problems involving a series of steps or processes.<br>Defines variables from text to draw networks and diagrams.<br>Organises data in a concise, clear format and appropriately presents it in tabular, diagrammatic and/or graphical form.<br>Identifies the underlying assumptions related to the relevant mathematics of an investigation. |
| | **Chooses effective models and methods and carries through the methods correctly**<br>Accurately applies mathematical knowledge and understanding to solve unstructured problems using sub-problems.<br>Generalises and extends models from previous parts of the question.<br>Translates between representations in unpractised ways.<br>Selects appropriate calculator techniques to solve multi-step problems in unfamiliar contexts.<br>Selects and appropriately uses numerical, graphical, symbolic and statistical methods to develop mathematical ideas.<br>Produces results, carries out analysis and generalises in situations requiring investigative techniques. |
| | **Follows mathematical conventions and attends to accuracy**<br>Follows mathematical conventions and attends to accuracy in non-routine situations.<br>Provides concise and accurate solutions to mathematical problems set in applied and theoretical contexts.<br>Selects, extends and applies mathematical and/or statistical procedures to investigate a problem. |
| | **Links mathematical results to data and contexts to reach reasonable conclusions**<br>Recognises implied conditions in real-life applications and defines and explains the limitations of models.<br>Interprets the result and draws the correct conclusion about the effect of changing conditions.<br>Considers the strengths and limitations of an investigation and refines the results to make sensible conclusions. |
| | **Communicates mathematical reasoning, results and conclusions**<br>Sets out the steps of the solution in a clear and logical sequence, including suitable justification and explanation of methods and processes used.<br>Adds a detailed diagram to illustrate and use in the solution of a problem.<br>Presents work with the final answer clearly identified, using the correct units and relating to the context of the question.<br>Communicates investigation findings with a comprehensive interpretation of mathematical results in the context of the investigation. |

| | |
|---|---|
| **B** | **Identifies and organises relevant information**<br>Identifies and organises relevant information for problems involving a few steps or processes.<br>Draws a network or diagram and labels with appropriate variables.<br>Organises data clearly and appropriately presents it in tabular, diagrammatic and/or graphical form.<br>Identifies suitable variables and constant parameters related to various aspects of an investigation. |
| | **Chooses effective models and methods and carries through the methods correctly**<br>Selects an appropriate strategy and applies mathematical knowledge to solve problems that contain a few steps.<br>Translates between representations in practised ways.<br>Selects appropriate calculator techniques to solve multi-step problems.<br>Selects and appropriately uses numerical, graphical, symbolic and statistical methods to develop mathematical ideas.<br>Attempts to analyse and calculate specific cases of generalisation in situations requiring investigative techniques. |
| | **Follows mathematical conventions and attends to accuracy**<br>Interprets and uses mathematical terminology, symbols and conventions in routine situations.<br>Rounds, unprompted, to suit context or correctly to specified accuracy.<br>Completes mostly accurate solutions to mathematical problems set in applied and theoretical contexts.<br>Selects and applies mathematical and/or statistical procedures previously learned to investigate a problem. |
| | **Links mathematical results to data and contexts to reach reasonable conclusions**<br>Identifies specified conditions in real-life applications, and recognises and rejects inappropriate solutions.<br>Links the effect of changing conditions to the original solution.<br>Uses examples in mathematical analysis of an investigation and draws valid conclusions related to a given context. |
| | **Communicates mathematical reasoning, results and conclusions**<br>Carries through calculations and simplifications in a clear sequence, showing a logical line of reasoning.<br>Defines variables associated with a given diagram and uses them in the working of a problem.<br>Presents work with the final answer clearly identified and using the correct units.<br>Communicates investigation findings in a systematic and concise way using mathematical language and relating the solution to the original problem or statement. |

| | |
|---|---|
| **C** | **Identifies and organises relevant information**<br>Identifies and extracts key information needed to solve a familiar problem.<br>Identifies variables in a network or diagram.<br>Organises some data and presents it in tabular, diagrammatic and/or graphical form.<br>Identifies some mathematical content related to various aspects of an investigation in a given context. |
| | **Chooses effective models and methods and carries through the methods correctly**<br>Selects a strategy and applies mathematical knowledge to answer structured questions that require short responses.<br>Recognises and uses information in different representations.<br>Uses familiar calculator applications to solve routine problems.<br>Selects appropriate numerical, graphical, symbolic and statistical methods to carry through a single thread of reasoning in situations requiring investigative techniques. |
| | **Follows mathematical conventions and attends to accuracy**<br>Applies mathematical definitions, rules and procedures in practised situations.<br>Applies basic conventions for diagrams and graphs.<br>Rounds appropriately in a given context and to specified accuracy in short responses.<br>Generates some accurate and generally complete solutions to mathematical problems set in applied and theoretical contexts.<br>Selects and applies, with direction, mathematical and/or statistical procedures previously learned to investigate a problem. |
| | **Links mathematical results to data and contexts to reach reasonable conclusions**<br>Identifies specified conditions in real-life applications and recognises inappropriate solutions in routine problems.<br>Recognises that changing conditions will affect the outcome.<br>Makes inferences from analysis and uses these to draw conclusions related to an investigation. |
| | **Communicates mathematical reasoning, results and conclusions**<br>Shows adequate working and supports answers with simple or routine statements.<br>Relates the working to a labelled diagram that has been given as part of the question.<br>Presents a solution but the final answer is not always clearly identified.<br>Communicates investigation findings in a systematic way using some mathematical expression and everyday language. |

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| **D** | **Identifies and organises relevant information**<br>Uses given information to solve simple routine problems.<br>Identifies variables in a simple network or diagram.<br>Displays data using an inappropriate presentation format.<br>Identifies limited mathematical content of an investigation. |
| | **Chooses effective models and methods and carries through the methods correctly**<br>Follows an appropriate strategy to solve simple routine and familiar problems that require short responses.<br>Deals with information in familiar representations only.<br>Uses a calculator for straightforward problems.<br>Makes some attempt to select appropriate numerical, graphical, symbolic and statistical methods in situations requiring investigative techniques. |
| | **Follows mathematical conventions and attends to accuracy**<br>Applies limited mathematical conventions to practised problems.<br>Rounds inconsistently or inappropriately.<br>Generates partly accurate and generally incomplete solutions to mathematical problems set in applied and theoretical contexts.<br>Attempts to apply, with direction, mathematical and/or statistical procedures previously learned to investigate a problem. |
| | **Links mathematical results to data and contexts to reach reasonable conclusions**<br>Attempts to recognise specified or changing conditions in real-life applications.<br>Draws some conclusions from the results of an investigation. |
| | **Communicates mathematical reasoning, results and conclusions**<br>Shows some working in an attempt to answer simple questions.<br>Sets out calculations in a manner that is difficult to check for accuracy.<br>Presents working with no indication of the final answer evident.<br>Offers simple conclusions that are not supported by data or calculations. |

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| **E** | Does not meet the requirements of a D grade and/or has completed insufficient assessment tasks to be assigned a higher grade. |

* These grade descriptions will be reviewed at the end of the second year of implementation of this syllabus.

# Appendix 2 – Glossary

This glossary is provided to enable a common understanding of the key terms in this syllabus.

## Unit 3

### Bivariate data analysis

**Association**
Association is a general term used to describe the relationship between two (or more) variables. For example, a categorical association between t-shirt prices (less than $20, $20–$40, more than $40) and student school years (primary, lower secondary, upper secondary) may be observed. A numerical association between a person's height and foot length may exist.

**Categorical variable**
A categorical variable is a variable whose values are categories, such as blood groups (A, B, AB or O) or shirt sizes (S, M, L, XL). Categories may have numerical labels; for example, income bracket ($0–$20k, $20–$30k, $30–$40k, $40–$50k). They serve as labels for the categories.

**Coefficient of determination**
In a linear model between two variables, the coefficient of determination, denoted by $R^2$ or $r^2$, is a statistical measure of how well a regression line predicts actual data points. It indicates the proportion of the total variation that can be explained by the relationship existing between the two variables, usually expressed as a percentage. For two variables only, the coefficient of determination is numerically equal to the square of the correlation coefficient.

Note: the coefficient of determination has a more general and more important meaning in considering relationships between more than two variables, but this is not a school-level topic.

**Correlation coefficient (r)**
The correlation coefficient ($r$) is a measure of the strength and direction of the linear relationship between a pair of variables where $-1 \leq r \leq 1$. Calculating $r$ may be performed using appropriate technology.

**Extrapolation**
In the context of fitting a linear relationship between two variables, extrapolation occurs when the model is used to make predictions using values that are outside the range of the original data.

**Interpolation**
In the context of fitting a linear relationship between two variables, interpolation occurs when the model is used to make predictions using values that lie within the range of the original data.

**Least-squares regression line**
The least-squares regression line, in the form $y = ax + b$, represents a linear relationship between the response variable $y$ and the explanatory variable $x$. The line represents the overall trend and can be used to predict outcomes.

The equation for the least-squares regression line may be determined via the use of appropriate technology.

**Non-causal links**
Non-causal links are factors that may contribute to an observed association between two variables. Knowing that two variables are associated, no matter how strongly, is not sufficient evidence by itself to conclude that the two variables are causally related. Non-causal explanations for an observed association between an explanatory and a response variable may include coincidence, or a common response to a confounding variable.

**Residual plot**
A residual plot is a scatterplot with the residual values shown on the vertical axis and the explanatory variable shown on the horizontal axis.

**Residual values**
The difference between the observed/recorded value and the value predicted by a statistical model; for example, by a least-squares regression line.

**Scatterplot**
A scatterplot is a two-dimensional data plot using Cartesian coordinates to display the values of two variables in a bivariate data set.

**Stacked percentage graph**
A stacked percentage graph is a bar graph displaying the percentage contribution of responses to each category.

**Two-way relative frequency table**
A two-way relative frequency table displays the values as a percentage or proportion of the total in each row or column. The table shows the proportion in each response category for the explanatory variable.

**Validity**
The extent to which the analysis of statistical data yields accurate and realistic results in terms of the context.

## Growth and decay in sequences

**Arithmetic sequence**
An arithmetic sequence is a sequence of terms where the difference between any two successive terms of the sequence is constant.

**Converging series (geometric)**
A converging series is a geometric sequence of infinite terms that sum to a limiting value.

**Exponential growth or decay (sequence)**
A sequence displays exponential growth or decay when each term is some constant multiple (greater than zero) of the preceding term. A multiple greater than one corresponds to growth. A multiple greater than zero but less than one corresponds to decay.

**First-order linear recurrence relation**
A first-order linear recurrence relation calculates the next term by multiplying the previous term by a constant and adding or subtracting a constant term.

**General rule**
A general rule is an equation that defines a sequence using a rule for the $n^{th}$ term $t_n$ of the sequence.

**Geometric sequence**
A geometric sequence is a sequence of terms where the ratio between any two successive terms of the sequence is constant.

**Linear growth or decay (sequence)**
A sequence displays linear growth or decay when the difference between successive terms is constant. A positive constant difference corresponds to linear growth, while a negative constant difference corresponds to decay.

**Recursive rule**
A recursive rule is an equation that recursively defines a sequence; that is, given one or more initial terms, each further term of the sequence is defined as a function of the preceding term.

**Steady-state solution**
A steady-state solution is the value that the terms of a first-order linear recurrence relation approach over the long term.

## Pythagoras and trigonometry in two dimensions

**Bearing (compass and true)**
A bearing is the direction of a fixed point, or the path of an object, from the point of observation. Compass bearings are specified as angles either side of north or south. For example, N50° E and true bearings are measured in degrees from the north line, e.g. 090°.

## Graphs and networks in action

**Dijkstra's algorithm**
A systematic method used to determine the shortest path between two vertices in a weighted graph by choosing the nearest unvisited vertex and summing the distances until the destination is reached.

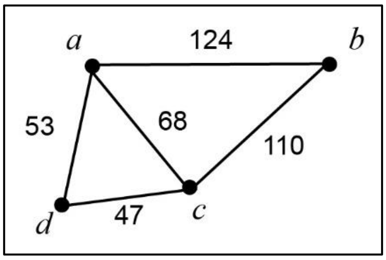
**Greedy algorithm**
A systematic approach that involves choosing the optimal value at each step of the problem without considering the next steps in solving.

**Kruskal's algorithm**
A greedy algorithm used to determine the minimal spanning tree in a weighted graph by sorting and selecting the edges with the smallest weighting and building a connected graph using all vertices but with no cycles.

**Minimum spanning tree**
For a connected weighted graph, the minimum spanning tree is the subgraph that connects all vertices using a minimum length.

**Prim's algorithm**
A greedy algorithm used to determine the minimal spanning tree in a weighted graph by choosing the nearest neighbour to a chosen vertex and continuing until all vertices are connected.

**Weighted graph (network)**
A weighted graph is a graph where each edge is labelled with a number that represents some quantity associated with the edge. For example, if the vertices represent towns, the weights on the edges may represent the distances in kilometres between the towns.




## Unit 4

### Time series analysis

**Average percentage method**
The average percentage method is used for calculating a seasonal index. The data for each ‘season’ are expressed as percentages of the average for the cycle. The percentages for the corresponding ‘seasons’ for different years are then averaged using a mean to arrive at a seasonal index.

**Deseasonalise (seasonal adjustment)**
To deseasonalise time series data is to remove periodic variations due to seasonal effects from the data.

**Length of cycles**
The length of a cycle is the time taken to complete a pattern of fluctuations.

**Seasonality**
A regular rise and fall in the time series that recurs each cycle. Seasonality is measured in terms of a seasonal index.

**Seasonal index**
The seasonal index is a percentage that represents how much each ‘season’ of the time series varies from the average season. An index value is attached to each season. For the ‘seasons’ of the cycle ‘morning, afternoon, night’ there are three separate seasonal indices; for months, there are 12 separate seasonal indices (one for each month), and so on.

**Simple moving average (mean)**
In time series data, a simple moving average is a method used to smooth the time series whereby each observation is replaced by the mean of the observation and its near neighbours. This process reduces the effect of non-typical data and makes the overall trend easier to see.

**Time series plot**
A time series plot is a line graph with time plotted on the horizontal axis and values recorded at given time intervals on the vertical axis.

## Loans and investments

**Annuity**
An annuity is a compound interest investment from which payments are made on a regular basis for a fixed period of time. At the end of this time, the investment has no remaining value.

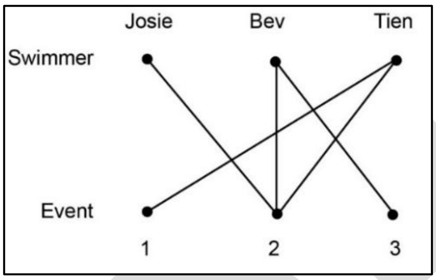
**Effective annual rate of interest**
The effective annual rate of interest is used to compare the interest paid on loans (or investments) with the same nominal annual interest rate but with different compounding periods (daily, monthly, quarterly, annually, other).

**Perpetuity**
A perpetuity is a compound interest investment from which payments are made on a regular basis for an infinite period of time, with the initial investment amount being maintained.

## Decision mathematics

**Backward scanning**
See Latest starting time.

**Bipartite graph**
A bipartite graph is a graph whose set of vertices can be split into two distinct groups in such a way that each edge of the graph joins a vertex in the first group to a vertex in the second group.




**Critical path**
The sequence of activities that define the longest path in a network, and hence the minimum time in which a project can be completed. There may be more than one critical path in a network.

**Dummy link**
A dummy link is an edge on a network that represents an activity of zero duration. The dummy link is drawn on a network diagram using a dotted line. It is necessary to use a dummy link in a project network if activities share some, but not all, of their immediate predecessors.

**Earliest starting time (EST)**
The earliest starting time of an activity is the longest time that it takes to complete all preceding activities. The process of systematically determining earliest starting times is called forward scanning.

**Feasible region**
The region defined by a set of inequalities on a Cartesian plane.

**Float time**
The amount of time that a task in a project network can be delayed without causing a delay to subsequent tasks is referred to as float time. All activities on a critical path have zero float time.

**Flow network**
A Flow network is a directed graph that shows the maximum flow through each edge of a network. A flow must satisfy the restriction that the amount of flow into a node equals the amount of flow out of it, except when it is a source or a sink.

**Forward scanning**
See Earliest starting time.

**Hungarian algorithm**
A systematic method used to solve assignment (allocation) problems by manipulating values of a matrix.

**Latest starting time (LST)**
The latest starting time of an activity is the time that the activity must commence to enable succeeding activities to be completed on time. The process of systematically determining latest starting times is called backward scanning.

**Objective function**
An equation that defines the value to be maximised or minimised by the restraints of a set of inequalities.

**Source**
A vertex in a directed graph which has outgoing edges only. See Flow network.

**Sink**
A vertex in a directed graph which has incoming edges only. See Flow network.