Dungog High School

Higher School Certificate Courses

Mathematics Faculty

2015-2016

Assessment Booklet
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Information for Students

- This booklet is an important document. It explains the outcomes of the course you are doing and how your assessment mark will be determined. It also gives a breakdown of all the content that is involved in each course allowing students to self-check they have covered all the work. The performance bands included, explain what you need to do to demonstrate your knowledge, understanding and skills.

- One assessment task may be used to measure a variety of outcomes.

- If you miss lessons it is your responsibility to find out if any information about assessment tasks were given out during the period of absence in addition to catching up any missed work. In cases of prolonged absence you should request that school work be sent home for you to complete.

- If you don’t understand what is required of you in any assessment task it is your responsibility to seek help from your class teacher or the Head Teacher.

- You will need to attend each lesson and complete all set work. The Board may refuse to grant a Higher School Certificate to a student whose application at school has been unsatisfactory. This could mean that poor attendance may result in you being deemed as not satisfactorily completing the course.

It is your responsibility to carefully read and understand this information.
GENERAL 1 MATHEMATICS

HSC Board of Studies Outcomes

MG1H-1 uses mathematics and statistics to evaluate and construct arguments in a range of familiar contexts
MG1H-2 analyses representations of data in order to make predictions
MG1H-3 makes predictions about everyday situations based on simple mathematical models
MG1H-4 analyses simple two-dimensional and three-dimensional models to solve practical problems
MG1H-5 interprets the results of measurements and calculations and makes judgements about reasonableness, including the conversion to appropriate units
MG1H-6 makes informed decisions about financial situations likely to be encountered post-school
MG1H-7 develops and carries out simple statistical processes to answer questions posed
MG1H-8 solves problems involving uncertainty using basic counting techniques
MG1H-9 chooses and uses appropriate technology to organise information from a range of practical and everyday contexts
MG1H-10 uses mathematical argument and reasoning to evaluate conclusions drawn from other sources, communicating a position clearly to others
MG1H-VA appreciates the importance of mathematics in everyday life and its usefulness in contributing to society

HSC Course Content

Financial Mathematics – 5 hours
FM4CEC: Credit cards

Data and Statistics – 15 hours
DS4CEC: Distributions
DS5CEC: Interpreting sets of data
DS6CEC: Working with statistics

Measurement – 5 hours
MM4CEC: Further applications of area and volume

Probability – 5 hours
PB2CEC: Multistage events and applications of probability

Algebra and Modelling – 10 hours
AM3CEC: Further algebraic skills
AM4CEC: Modelling with functions

Focus Studies
Mathematics and Design – 16 hours
FSDe1CEC: Scale drawings and house plans
FSDe2CEC: Design

Mathematics and Household Finance – 16 hours
FSHo1CEC: Accommodation costs: buying and renting
FSHo2CEC: Costs of running a household, maintenance, and repairs

Mathematics and the Human Body – 24 hours
FSHu1CEC: Blood
FSHu2CEC: Body measurements
FSHu3CEC: Lung capacity

Mathematics and Personal Resource Usage – 24 hours
FSPe1CEC: Water usage and collection
FSPe2CEC: Electricity
FSPe3CEC: Sustainability and energy-efficient housing

Note: Hours shown are indicative only.
Financial Mathematics

**FM4CEC: Credit Cards**
This topic focuses on the use of credit cards as a method of payment for goods and services. Students learn to read and interpret credit card statements, and to calculate the interest payable, the account balance, and the fees payable.

**Students learn and acquire the following skills, knowledge and understanding**

- interpret credit card statements and carry out related calculations
- create a 'ledger of spending' that includes the date and cost of purchases and the payment method
- identify the various fees and charges associated with credit card usage, including interest charges, annual card fees, and late payment fees, and how they are calculated
- express a percentage annual interest rate as a daily interest rate in percentage and decimal form
- calculate simple interest for one billing cycle
- compare differences between credit cards and debit cards.

Data and Statistics

**DS4CEC: Distributions**
In this topic, students learn to recognise and interpret properties of common statistical distributions. The principal focus of this unit is the use of data displays, measures of location and measures of spread to summarise and interpret one or more sets of data.

**Students learn and acquire the following skills, knowledge and understanding**

- create a smooth curve to represent the general shape of a distribution
- recognise and describe in general terms different distributions of data, including normal, skewed, uniform, symmetric, unimodal and bi-modal distributions
- give examples of data sets that are normal, skewed, uniform, symmetric, unimodal and bi-modal
- determine the position of the mode(s) for different distributions from a graphical representation of a distribution
- recognise the shape of a distribution in various graphical forms, eg histogram, dot plot, stem-and-leaf plot and box-and-whisker plot
- describe, for a given histogram, the shape of the distribution and how the shape relates to features of the associated population or sample
- identify the properties of data that are normally distributed, i.e.
  - the mean, median and mode are equal
  - if represented by a histogram, the resulting frequency graph (polygon) is 'bell-shaped'
- solve problems involving interpretation of the standard deviation, where the value of the standard deviation is given.

**DS5CEC: Interpreting Sets of Data**
The principal focus of this topic is the use of data displays, measures of location, and measures of spread to summarise and interpret one or more sets of data.

**Students learn and acquire the following skills, knowledge and understanding**

- identify measures of location: mean and median
- identify measures of spread: range, interquartile range and population standard deviation
- display data in double (back-to-back) stem-and-leaf plots
- display data in two box-and-whisker plots drawn on the same scale
- display two sets of data on a radar chart
- use multiple displays to describe and interpret the relationships between data sets
- interpret data presented in two-way table form, e.g. male/female versus exercise/no exercise
- compare summary statistics for two sets of data.

**DS6CEC: Working with Statistics**
In this topic, students learn to recognise and interpret common misconceptions in statistical reasoning.

**Students learn and acquire the following skills, knowledge and understanding**

- describe common misconceptions in statistical reasoning, including:
  - misconceptions involving averages (often referred to as the Reversal Paradox)
  - interpreting percentage change for a small population compared to a larger population
...misconceptions about sample size
- ‘the gambler’s fallacy’, eg after a run of heads when tossing a fair coin, a tail is more likely to occur on the next toss
- estimate the likelihood of events using a sample, based on how closely the sample matches the parent population.

Measurement

**MM4CEC: Further Applications of Area and Volume**
The principal focus of this topic is to extend the work commenced in MM2 *Applications of perimeter, area and volume* to include area of composite shapes, surface area, and volume of more complex figures.

*Students learn and acquire the following skills, knowledge and understanding*
- calculate the area of a circle
- calculate the area of an annulus from a given diagram
- calculate the area of a sector as a fraction of a circle
- estimate an area using a single application of Simpson’s rule over three equally spaced *h* points
  \[ A \approx \frac{h}{3} \left( d_f + 4d_m + d_l \right) \]
- calculate the surface area of a cube, rectangular prism, sphere, and closed cylinder
- calculate the volume of a right prism with an irregular base, where the area of the base is known
- calculate the volume of a hollow annular cylinder
- solve practical area, surface area and volume problems
- estimate and check to determine if results are reasonable.

Probability

**PB2CEC: Multi-stage Events and Applications of Probability**
The focus of this topic is on counting the number of outcomes for an experiment and the number of ways, in which an event can occur, and identifying the outcomes expected from simple experiments and comparing them with experimental results. The probability of particular outcomes and events can then be established.

*Students learn and acquire the following skills, knowledge and understanding*
- multiply the number of choices at each stage to determine the number of outcomes for a multistage event
- establish that the number of ways in which *n* different items can be arranged in a line is *n*(*n*−1)(*n*−2) .... × 1, eg the number of arrangements of four different items is 4 × 3 × 2 × 1 = 24; the number of arrangements of three different items is 3 × 2 × 1 = 6
- construct and use tree diagrams to establish outcomes for a simple two-stage event
- use probability tree diagrams to solve problems involving two-stage events
- calculate the expected number of times a particular event would occur, given the number of trials of a simple experiment, by establishing the theoretical probability of the event and multiplying by the number of trials
- compare the expected result with an experimental result
- calculate the financial expectation by multiplying each financial outcome by its probability and adding the results together.

Algebraic Modelling

**AM3CEC: Further Algebraic Skills**
In this topic, students develop algebraic skills and techniques that have applications in work-related and everyday contexts. These skills and techniques include the development of competency in finding the values of pronumerals following substitution in algebraic formulae.

*Students learn and acquire the following skills, knowledge and understanding*
- establish and apply index laws \( a^m \times a^n = a^{m+n} \), \( a^m \div a^n = a^{m-n} \), \((a^m)^n = a^{mn}\)
- apply index laws to simplify algebraic expressions, eg \((x^2)^4, 4x^2 \times 5x^3, 15w^2 \div 5w^3, 3p^2(p-2)\)
- solve equations, including equations where solution involves the removal of brackets and equations with an unknown in the denominator, eg \(3(a + 7) = 28, 15 = \frac{45}{h} - \frac{50}{15} = 175\)
- solve for a linear term in an equation following substitution into a mathematical formula from a vocational or other context, eg if \(B = \frac{m}{h^2}\) find *m* given that \(B = 23, h = 1.63\)

- estimate the likelihood of events using a sample, based on how closely the sample matches the parent population.
AM4CEC: Modelling with Functions
This topic focuses on modelling using linear and quadratic functions. Students learn to apply and graph these functions in vocational and other practical contexts.

Students learn and acquire the following skills, knowledge and understanding
- generate tables of values for linear functions (including for negative values of $x$)
- graph linear functions for all values of $x$ with pencil and paper, and with graphing software
- interpret the point of intersection and other important features of given graphs of two linear functions drawn from practical contexts, eg break-even point
- generate tables of values for quadratic functions of the form $y = ax^2$ and $y = ax^2 + c$ (including negative values of $a$ and $x$)
- graph quadratic functions with pencil and paper, and with graphing software
- explain the effect of changing the magnitude of $a$ and changing the sign of $a$
- explain the effect of changing the value of $c$
- identify the maximum and minimum values of a quadratic function from a prepared graph based on a practical context
- recognise the limitations of models when interpolating and/or extrapolating
- use linear and quadratic functions to model physical phenomena.

Focus Study: Mathematics and Design
FSDe1CEC: Scale Drawings and House Plans
In this topic, students interpret and use house plans, designs and maps in the calculation of a range of measurements and the solution of related problems.

Students learn and acquire the following skills, knowledge and understanding
- sketch plan views and elevation views of three-dimensional objects
- recognise parallel, perpendicular and intersecting lines, in the context of two-dimensional and three-dimensional representations of houses and buildings
- define and recognise planes in three-dimensional space in the context of three-dimensional representations of houses and buildings
- interpret common symbols and abbreviations on house plans
- use the scale on a plan, design or map to calculate actual dimensions, and vice versa
- interpret plan views and elevation views to obtain internal dimensions of rooms
- calculate area and volume based on information on a plan
- apply right-angled triangle trigonometry and Pythagoras' theorem to solve problems based on plans, including finding the pitch of a roof.

FSDe2CEC: Design
In this topic, students learn to identify and apply various concepts important in design, including scale factors, similarity and symmetry. In producing sketches, constructions and designs, they use geometrical instruments as well as computer software.

Students learn and acquire the following skills, knowledge and understanding
- enlarge and reduce plane shapes by a specified scale factor, using a ruler and a pair of compasses
- recognise and apply similarity to calculate lengths and areas of regular and irregular plane shapes
- sketch common three-dimensional objects, including rectangular and triangular prisms, cylinders, pyramids and cones
- recognise parallel, perpendicular and intersecting lines in two-dimensional shapes and three-dimensional objects
- identify line and radial symmetry (rotational symmetry) in common mathematical shapes, designs, artworks and architecture
- create, with the aid of a ruler, examples of simple perspective drawings
- identify examples of the golden ratio in art and design by appropriate calculation
- recognise and construct simple tessellations of three kinds: regular, semi-regular and non-regular
- construct a simple design by hand and with technology, using common geometrical shapes.
Focus Study: Mathematics and Household Finance

FSHo1CEC: Accommodation Costs: Buying and Renting

In this topic, students calculate costs involved in purchasing and renting houses and units, and use tables and graphs that they have constructed in relation to home loans. Students also investigate changes in housing and renting costs over time and the effect of changes in interest rates.

Students learn and acquire the following skills, knowledge and understanding

- calculate the affordability of accommodation based on income, using generalised rules such as monthly payments should not be greater than a certain percentage of income; and the amount to be borrowed should not exceed a certain multiple of the annual household income
- calculate the costs involved in purchasing a house or unit, including stamp duty, mortgage application fees, and conveyancing
- calculate the costs involved in renting a house or unit, including the cost of a rental bond
- use published tables from financial institutions to determine monthly repayments on a reducing balance home loan
- use monthly repayment tables for a home loan to calculate the total amount to be repaid and the total interest to be paid
- construct a graph of changes in interest rates over a given period of time
- construct tables and graphs using online loan calculators to investigate the implications of changes to interest rates, changes in minimum repayments, and changes in the length of the total repayment period for a loan.

FSHo2CEC: Cost of running a household, maintenance, and repairs

The principal focus of this topic is the calculation and comparison of household running, maintenance and repair costs. Students also investigate ways to reduce household expenditure and minimise wastage.

Students learn and acquire the following skills, knowledge and understanding

- compare the costs of various insurances, including public liability, building, contents, income protection, and personal insurance
- investigate body-corporate and strata levies
- read and interpret common household bills, including bills for electricity, gas, telephone, council rates, land tax, water, and body-corporate and strata levies
- perform calculations based on information contained in common household bills
- investigate ways in which household expenditure can be reduced, eg efficient shower heads, and more efficient light globes and appliances
- calculate the costs of common repairs carried out by tradespeople, given the hourly rate and the cost of materials
- perform calculations for home additions, renovations, repairs and maintenance
- construct a scale diagram of a room
- calculate the cost of repainting rooms based on the calculation of the area of the walls and ceilings
- calculate the amount of floor covering required for a room
- prepare a budget reflecting the costs of running a household.

Focus Study: Mathematics and the Human Body

FSHu1CEC: Blood

In this topic, students interpret charts, construct graphs, and perform a range of calculations in relation to blood and heart rate. They identify trends and make predictions based on their calculations.

Students learn and acquire the following skills, knowledge and understanding

- describe heart rate as a rate expressed in beats per minute
- measure and graph a person’s heart rate over time under different conditions, eg at rest, during exercise, and after exercise
- identify mathematical trends in heart rate over time under different conditions
- calculate the total number of heart beats over a given time under different conditions
- calculate Targeted Heart Rate ranges during training
- express blood pressure using measures of systolic pressure and diastolic pressure
- measure blood pressure over time and under different conditions
- read a blood pressure chart and interpret the ‘healthiness’ of a reading
- interpret data in a blood compatibility chart as an alternative presentation of data in a two-way table
• predict, by calculation, the number of people of each blood type in a population given the percentage breakdowns
• predict, by calculation, the expected number of people of a particular blood type in a population.

**FSHu2CEC: Body Measurements**
In this topic, students construct scatterplots and lines of fit and use them to explore relationships and make predictions. They use technology to calculate correlation coefficients and interpret the strength of association of variables.

*Students learn and acquire the following skills, knowledge and understanding*
• investigate biometric data obtained by measuring the body and by accessing published data
• plot ordered pairs of body measurement data onto a scatterplot by hand and by using appropriate technology
• recognise patterns in a scatterplot of body measurements, eg
  – whether the points appear to form a mathematical pattern
  – whether the pattern appears to be linear
• construct a line of fit and determine the equation, by hand and by using appropriate technology
• use the equation of a line of fit to make predictions about body measurements
• recognise the practical limitations of the equation of a line of fit
• calculate correlation coefficients for different body measurements using appropriate technology (students are not required to calculate correlation coefficients by hand)
• interpret the strength of association for different body measurements using a given correlation coefficient
• interpret the sign of a given correlation coefficient.

**FSHu3CEC: Lung Capacity**
In this topic, students recognise lung capacity as a volume and perform a range of related calculations. They compare estimated and theoretical values where relevant.

*Students learn and acquire the following skills, knowledge and understanding*
• recognise lung capacity as a volume by obtaining values for Estimated Vital Lung Capacity by practical means, and statistically analyse the values
• calculate a person’s Theoretical Vital Lung Capacity (in litres)
• convert lung capacity from cubic centimetres to litres \(1\,cm^3 = 1\,mL = 0.001\,L\), \(1000\,cm^3 = 1\,L\)
• compare values of Estimated Vital Lung Capacity with theoretical values.

**Focus Study: Mathematics and Personal Resource Usage**

**FSPe1CEC: Water Usage and Collection**
In this topic, students interpret information, make comparisons, and perform a range of calculations in relation to personal water usage.

*Students learn and acquire the following skills, knowledge and understanding*
• interpret information about a household’s water usage, eg a household water bill
• collect and interpret data and calculate statistics on household and personal water usage
• construct and interpret rainfall graphs
• calculate the volume of water collected, based on a catchment area, using \(V = Ah\)
• calculate the volume of water held by tanks of various shapes and sizes
• compare the amount of water used by a household and the amount of rainfall that could be collected over a given period
• calculate the amount of water that could be saved by initiating changes to household water use, including changing fittings, recycling grey water, and collecting and recycling stormwater.

**FSPe2CEC: Electricity**
The principal focus of this topic is the calculation and comparison of household electricity consumption and cost, and the calculation and interpretation of related statistics.

*Students learn and acquire the following skills, knowledge and understanding*
• interpret information about a household’s electricity usage, eg a household electricity bill
• calculate the cost of running different household appliances for various time periods, given the power rating, usage time, and cost of power
• interpret the energy rating of appliances and compare running costs of different models of the same type of appliance
• calculate the amount of electricity that could be saved by using energy-efficient devices and adopting energy-efficient strategies.

**FSPe3CEC: Sustainability and Energy-Efficient Housing**

In this topic, students interpret information, make comparisons, and perform a range of calculations in relation to requirements and data relevant to sustainability and energy-efficient housing.

**Students learn and acquire the following skills, knowledge and understanding**

• calculate building sustainability measures based on the requirements of the Building Sustainability Index (BASIX) Certificate
• identify the issues addressed in the BASIX, eg area of site, water, thermal comfort, and energy
• calculate the site area of a proposed development, given a site plan
• calculate the roof area of a building from a plan
• calculate the ratio of floor area for which air conditioning applies to the floor area for which air conditioning does not apply
• calculate garden and lawn area, including low and high water-use areas
• calculate the volume of a tank, swimming pool and/or spa
• calculate the floor area of a building from a plan
• interpret measurements of wall heights and wall thicknesses from a plan
• measure the size of eaves from a plan
• calculate the amount of roof insulation required for a building from a plan
• determine the orientation of windows and skylights using a plan
• determine the breeze path on a plan.
# Dungog High School Mathematics Faculty
## Teaching Program Timeline
### Year 12 General 1 Mathematics Course 2015-2016

### Term 4 15

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<tr>
<td><strong>Week 1</strong></td>
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<td><strong>Week 2</strong></td>
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<td>Interpreting Sets of Data (DS5CEC)</td>
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*Note: The position of the assessments on this timeline are only suggestive. Actual written notification will be given to every student at least 2 weeks prior to the assessment task.*
# HSC ASSESSMENT GRID
## SUBJECT: GENERAL 1 MATHEMATICS

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<th>Task 5</th>
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(Note: The dates of tasks are flexible) This table should be read in conjunction with the above table and the Applied Mathematics Timeline.

### Nature of Assessment Task

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### Task Test/Ass Topics Weighting (%)

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<td>Mathematics and Personal Usage (Focus Study)</td>
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<td>Further Algebra Skills</td>
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<td>Multistage Events and Application of Probability</td>
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<td>4</td>
<td>T4</td>
<td>Further Application of Area and Volume</td>
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<td>Interpreting Sets of Data</td>
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<td>T4R</td>
<td>Test 4 Corrections</td>
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<td>A3</td>
<td>Mathematics and Design (Focus Study)</td>
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<td>Mathematics and the Human Body (Focus Study)</td>
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</table>
GENERAL 2 MATHEMATICS

HSC Board of Studies Outcomes

MG2H-1 uses mathematics and statistics to evaluate and construct arguments in a range of familiar and unfamiliar contexts
MG2H-2 analyses representations of data in order to make inferences, predictions and conclusions
MG2H-3 makes predictions about situations based on mathematical models, including those involving cubic, hyperbolic or exponential functions
MG2H-4 analyses two-dimensional and three-dimensional models to solve practical problems, including those involving spheres and non-right-angled triangles
MG2H-5 interprets the results of measurements and calculations and makes judgements about reasonableness, including the degree of accuracy of measurements and calculations and the conversion to appropriate units
MG2H-6 makes informed decisions about financial situations, including annuities and loan repayments
MG2H-7 answers questions requiring statistical processes, including the use of the normal distribution, and the correlation of bivariate data
MG2H-8 solves problems involving counting techniques, multistage events and expectation
MG2H-9 chooses and uses appropriate technology to locate and organise information from a range of contexts
MG2H-10 uses mathematical argument and reasoning to evaluate conclusions drawn from other sources, communicating a position clearly to others, and justifies a response
MG1H-VA appreciates the importance of mathematics in everyday life and its usefulness in contributing to society

HSC Course Content

Strands 80 hours

Financial Mathematics
  FM4: Credit and borrowing
  FM5: Annuities and loan repayments

Data and Statistics
  DS4: Interpreting sets of data
  DS5: The normal distribution
  DS6: Sampling and populations

Measurement
  MM4: Further applications of area and volume
  MM5: Applications of trigonometry
  MM6: Spherical geometry

Probability
  PB2: Multistage events and applications of probability

Algebra and Modelling
  AM3: Further algebraic skills and techniques
  AM4: Modelling linear relationships
  AM5: Modelling non-linear relationships

Mathematics and Health
  FSHHe1: Body measurements
  FSHHe2: Medication
  FSHHe3: Life expectancy

Mathematics and Resources
  FSRe1: Water availability and usage
  FSRe2: Dams, land and catchment areas
  FSRe3: Energy and sustainability

Total indicative hours 120 hours
Financial Mathematics

**FM4 Credit and borrowing**
This topic focuses on the mathematics involved in borrowing money, the different types of loans available, and credit cards.

**Students learn and acquire the following skills, knowledge and understanding**
- calculate credit card payments, interest charges, and balances
- calculate principal, interest and repayments for flat-rate loans
- calculate values in a table of loan repayments
- recognise that \( P \), the principal (or initial amount) in calculations with the compound interest formula 
  \[ A = P(1 + r)^n \] is the 'present value' \( (PV) \) and \( A \), the final amount, is the future value' \( (FV) \)
- calculate future value and present value using the formula \( FV = PV(1 + r)^n \)
- compare different options for borrowing money in relation to total repayments, fees, interest rates.

**FM5 Annuities and loan repayments**
The principal focus of this topic is the nature and mathematics of annuities, the processes by which they accrue, and ways of maximising their value as an investment. Annuity calculations are also used to calculate the present value of a series of payments and to calculate the repayment amount of a reducing-balance loan. Emphasis should be placed on using tables of interest factors to facilitate calculations.

**Students learn and acquire the following skills, knowledge and understanding**
- recognise that an annuity is a financial plan involving periodical, equal contributions to an account, with interest compounding at the conclusion of each period
- calculate (i) the future value of an annuity \( (FVA) \) and (ii) the contribution per period, using a table of future value interest factors for calculating a single future value of an annuity stream
- recognise that the values in a table of future value interest factors can be obtained using the formula for the future value of an annuity
- calculate (i) the present value of an annuity \( (PVA) \) and (ii) the contribution per period, using a table of present value interest factors for calculating a single present value of an annuity stream
- recognise that the values in a table of present value interest factors can be obtained using the formula for the present value of an annuity
- use a table of interest factors for the present value of an annuity to calculate loan instalments, and hence the total amount paid over the term of a loan
- investigate the various processes for repayment of loans
- calculate the monthly repayment for a home loan from a table, given the principal, rate and term
- calculate the fees and charges that apply to different options for borrowing money in order to make a purchase
- interpret graphs that compare two or more repayment options for home loans.

Data and Statistics

**DS4 Interpreting sets of data**
The principal focus of this topic is the use of data displays, measures of location, and measures of spread to summarise and interpret one or more sets of data, in which the data is either ungrouped or grouped.

**Students learn and acquire the following skills, knowledge and understanding**:
- represent large data sets as grouped data using frequency tables and histograms
- compare histograms for grouped data when varying the size of the class interval
- estimate measures of location, including median, upper and lower quartiles, from frequency tables, cumulative frequency tables, and cumulative frequency histograms and polygons
- calculate measures of location for grouped data: mean, mode and median
- calculate measures of spread: range, interquartile range, and population standard deviation
- calculate and make comparisons of the population standard deviations of two or more sets of data
- identify outliers in data sets and their effect on the mean, median and mode
- describe the general shape of a graph or display that represents a given data set, eg in terms of smoothness, symmetry, skewness or number of modes
- make judgements about data based on observed features of a display
- display data in double (back-to-back) stem-and-leaf plots
- display data in two box-and-whisker plots drawn on the same scale
- determine the percentages of data between any two quartiles on a box-and-whisker plot
- display two sets of data on a radar chart

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• use side-by-side multiple displays of the same data set, eg a side-by-side histogram and a box-and-whisker plot
• prepare an area chart to illustrate and compare different sets of data over time
• use multiple displays to describe and interpret the relationships between data sets
• compare summary statistics, including mean, mode, median, and population standard deviation, for two sets of data
• interpret data presented in two-way table form, eg male/female versus exercise/no exercise
• group and compare variables within the same data set using cross-tabulation.

**DS5 The normal distribution**

In this topic, students apply properties of the standard normal distribution to the solution of real-life problems.

**Students learn and acquire the following skills, knowledge and understanding:**

• describe the z-score (standardised score) corresponding to a particular score in a set of scores as a number indicating the position of that score relative to the mean
• use the formula $z = \frac{x - \mu}{\sigma}$ to calculate z-scores, where $\sigma$ is the standard deviation
• use calculated z-scores to compare scores from different data sets
• identify properties of data that are normally distributed, eg
  – the mean, median and mode are equal
  – if represented by a histogram, the resulting frequency graph is ‘bell-shaped’
• use collected data to illustrate that for normally distributed data:
  – approximately 68% of scores will have z-scores between –1 and 1
  – approximately 95% of scores will have z-scores between –2 and 2
  – approximately 99.7% of scores will have z-scores between –3 and 3
• use these measures to make judgements in individual cases.

**DS6 Sampling and populations**

In this topic, students apply knowledge, skills and understanding developed in relation to counting techniques and statistical methods to select samples and draw conclusions about populations.

**Students learn and acquire the following skills, knowledge and understanding:**

• recognise that a sample can be used to provide an estimate for a particular population characteristic when the entire population cannot be assessed
• apply counting techniques to list all possible samples of varying sizes from a known small population (population sizes up to $n = 5$, sample sizes varying from $n = 1$ to $n = 5$)
• verify that the mean of the distribution of all possible sample means is equal to the population mean ($\mu$) for populations (population sizes up to $n = 5$)
• describe and use the capture/recapture technique for estimating the size of populations, eg the number of fish in a lake
• generate random numbers with a table, calculator or spreadsheet to assist in establishing random samples
• recognise the effect of sample size in estimating the nature of a population, eg using the number of boys and girls in a particular Year 11 class to estimate the gender ratio in Year 11 across NSW.

**Measurement**

**MM4 Further applications of area and volume**

The principal focus of this topic is to extend knowledge, skills and understanding developed in relation to perimeter, area and volume in the Preliminary Mathematics General course to include the surface area and volume of complex figures and the use of approximations in calculating the area and volume of irregular figures.

**Students learn and acquire the following skills, knowledge and understanding:**

• calculate the percentage error in a measurement, eg if the measured height was 155 cm ± 0.5 cm (ie to the nearest centimetre), the percentage error for this measurement is $\pm \left(\frac{0.5}{155}\right) \times 100\%$
• calculate areas of annuluses and parts of a circle (quadrant, sector), using appropriate formulae (area of annulus: $A = \pi(R^2 - r^2)$)
• calculate areas of composite figures constructed from squares, rectangles, triangles and circles
• apply Simpson’s rule over three equally spaced points, ie one application (using $A = \frac{h}{3} (d_f + 4d_m + d_l)$)

• calculate the surface area of right prisms

• calculate the surface area of cylinders (without ‘top’ and/or ‘bottom’) and closed cylinders ($Surface\ Area\ closed\ cylinder = 2\pi r^2 + 2\pi rh$)

• calculate the surface area of spheres ($Surface\ Area\ sphere = 4\pi r^2$)

• calculate the volume of a cone, square pyramid and rectangular pyramid using appropriate formulae ($Volume = \frac{1}{3}Ah$)

• calculate volumes of composite solids

• calculate the volume of an annular cylinder

• calculate the volume of right prisms, where the base is a composite or irregular two-dimensional shape, eg an I-beam

• determine errors in calculations resulting from errors made in measurement.

**MM5 Applications of trigonometry**

The principal focus of this topic is to extend students’ knowledge, skills and understanding in trigonometry to include trigonometry involving non-right-angled triangles. Problems to be solved include problems involving offset and radial surveys.

**Students learn and acquire the following skills, knowledge and understanding:**

• draw diagrams to represent information given about a right-angled triangle

• solve problems using trigonometric ratios in one or more right-angled triangles

• solve problems involving angles of elevation and depression, given the appropriate diagram

• establish the sine, cosine and tangent ratios for obtuse angles using a calculator

• determine the sign of the above ratios for obtuse angles

• use the sine rule to find side lengths and angles of triangles

• use the cosine rule to find side lengths and angles of triangles

• calculate the area of a triangle using the formula $A = \frac{1}{2}absinC$

• use appropriate trigonometric ratios and formulae in ‘two-triangle problems’, where one triangle is right-angled and the diagram is given

• use compass bearings (eight points only) and true bearings (three-figure bearings) in problem-solving related to maps and charts

• select and use appropriate trigonometric ratios and formulae to solve problems involving right-angled and non-right-angled triangles

• conduct radial (both plane table and compass) surveys

• solve problems involving non-right-angled triangle trigonometry, Pythagoras’ theorem, and area in offset and radial surveys.

**MM6 Spherical geometry**

The principal focus of this topic is to apply geometry and trigonometry to solve problems related to the Earth as a sphere. Applications include locating positions on the surface of the Earth using latitude and longitude, and calculating time differences.

**Students learn and acquire the following skills, knowledge and understanding:**

• calculate arc length of a circle using the formula $l = \frac{\theta}{360}2\pi r$

• distinguish between great and small circles

• use the equator and the Greenwich Meridian as lines of reference for locations on the Earth’s surface

• locate positions on the surface of the Earth using latitude and longitude

• calculate distances, in kilometres, between two points on the same great circle

• use time zones and the International Date Line in solving problems

• calculate time differences between locations on the Earth given the difference in longitude

• determine the times in cities in different countries in travel questions.

**Probability**

**PB2 Multistage events and applications of probability**

The focus of this topic is on counting the number of outcomes for an experiment, or the number of ways in which an event can occur, and the calculation of outcomes expected from simple experiments and comparing them with experimental results. The probability of particular outcomes can then be established.

**Students learn and acquire the following skills, knowledge and understanding:**
Students learn and acquire the following skills, knowledge and understanding in the graphing of functions in different contexts.

AM4 Modelling linear relationships

This topic focuses on the solution of practical problems arising from situations that can be modelled algebraically and graphically using linear functions. Students develop knowledge, skills and understanding in the graphing of functions in different contexts.

Students learn and acquire the following skills, knowledge and understanding:

• use the graph in the previous dot point to establish the value of m (the gradient) and to solve problems related to the given variation context
• interpret linear functions as models of physical phenomena
• establish the meaning of the gradient and the y-intercept for a given practical context
• develop linear equations from descriptions of situations in which one quantity varies directly with another
• solve contextual problems involving linear models
• interpret the point of intersection of the graphs of two linear functions drawn from practical contexts
• solve contextual problems using a pair of simple linear simultaneous equations
• develop and use linear functions to model physical phenomena
• recognise the limitations of models when interpolating and/or extrapolating
• apply break-even analysis to simple business problems that can be modelled with linear and quadratic functions.

**AM5 Modelling non-linear relationships**

This topic focuses on the solution of practical problems arising from situations that can be modelled algebraically and graphically using non-linear functions. Students develop knowledge, skills and understanding in the graphing of functions in different contexts.

**Students learn and acquire the following skills, knowledge and understanding:**
• use a graph of a quadratic function to find maximum and minimum values in practical contexts
• recognise, graph and compare, by completing tables of values, the properties of the graphs of:
  
  \[ y = ax^2 + c, \text{ for all values of } x, \ y = ax^3 + c, \text{ for all values of } x, \ y = \frac{a}{x}, a > 0, \text{ for all values of } x, \ 
  
  \ y = b(a^x), x \geq 0. \]
• solve contextual problems involving exponential growth
• use algebraic functions (as described above) to model physical phenomena
• recognise the limitations of models when interpolating and/or extrapolating
• develop equations of the form \( y = ax^2, h = at^3 \) from descriptions of situations in which one quantity varies directly as a power of another
• develop equations such as \( y = \frac{a}{x} \) from descriptions of situations in which one quantity varies inversely with another
• evaluate \( a \) in the equations shown in the previous two dot points, given one pair of variables, and use the resulting formula to find other values of the variables.

**Focus Study: Mathematics and Health**

**FSHe1 Body measurements**

In this topic, students construct scatterplots and lines of fit and use them to explore relationships and make predictions. They use technology to calculate correlation coefficients and interpret the strength of association of variables, and to calculate the equation for the line of best fit using the least-squares method.

**Students learn and acquire the following skills, knowledge and understanding:**
• investigate biometric data obtained by measuring the body and by accessing published data
• plot ordered pairs of body measurement data onto a scatterplot by hand and by using appropriate technology
• recognise patterns in a scatterplot of body measurements, eg
  – whether the points appear to form a mathematical pattern
  – whether the pattern appears to be linear
• estimate and draw ‘by eye’ a line of fit on a scatterplot
• calculate correlation coefficients for different body measurements using appropriate technology (students are not required to calculate correlation coefficients by hand)
• interpret the strength of association for different body measurements using a given correlation coefficient
• interpret the sign of a given correlation coefficient
• construct the least-squares line of best fit
• determine the least-squares line of best fit using the correlation coefficient (\( r \)), the mean of the \( x \) scores, and the mean of the \( y \) scores, and the standard deviation of the \( x \) scores and the standard deviation of the \( y \) scores

\[
\text{least-squares line of best fit } y = \text{gradient } \times x + \text{y-intercept}
\]

where: \( r \) is the correlation coefficient, calculated using appropriate technology \( \text{gradient } = r \times \frac{\text{standard deviation of } y \text{ scores}}{\text{standard deviation of } x \text{ scores}} \)

\[\text{y-intercept } = \bar{y} - (\text{gradient } \times \bar{x})\]

• use a least-squares line of best fit to interpolate
• recognise that a high degree of correlation for different body measurements does not necessarily imply causality.
FSHe2 Medication
In this topic, students perform a range of calculations related to child and adult medication. They apply various formulae in the solution of practical problems.

**Students learn and acquire the following skills, knowledge and understanding:**
- recognise the need for units of mass smaller than the gram
- convert grams (g) to milligrams (mg), and vice versa
- perform calculations involving concentrations expressed as mass/volume, eg 100 mg/5 mL or 100 mg in 5 mL
- calculate required dosages for children and adults from packets given age or weight
- calculate required dosages for children using various formulae
- calculate drip rates and dosage strengths.

FSHe3 Life expectancy
Life expectancy is the number of years a person of a particular age today can expect to live, on average. In this topic, students perform a range of calculations related to life expectancy. They apply various mathematical techniques, including modelling, to interpret life expectancy data and make relevant predictions.

**Students learn and acquire the following skills, knowledge and understanding:**
- interpret life expectancy data in various forms, including in tables and graphs
- plot life expectancy data for a range of variables (eg country of birth and country’s population, gross domestic product (GDP), birth rate, infant mortality rate, spending on health care, percentage of urbanisation, etc), using the most appropriate form of display
- investigate trends, or points of significance, for specific countries over time, including any specific historical events such as medical advancements
- interpolate from plotted data to make predictions where appropriate
- interpret published graphs and statistics, including critically evaluating data collection methods, eg bias in data that may be included or omitted
- construct scatterplots of life expectancy for a range of variables, eg year of birth, gender, health status, etc
- create scatterplots for sets of variables to identify strong predictors of life expectancy, and calculate correlation coefficients
- plot life expectancy for different variables using online life expectancy calculators to make assessments about how variables are weighted, eg What effect does smoking have on a person’s life expectancy?

Focus Study: Mathematics and Resources
FSRe1 Water availability and usage
In this topic, students interpret information, make comparisons, and perform a range of calculations in relation to requirements and data relevant to water availability and usage.

**Students learn and acquire the following skills, knowledge and understanding:**
- interpret information about a household’s water usage, eg a household water bill
- collect and interpret data and calculate statistics on household and personal water usage
- investigate household water usage in different Australian and international locations
- construct and interpret rainfall graphs
- calculate the probability of rainfall in a locality
- compare rainfall in different regions, states and countries
- collect and interpret data and calculate statistics on water availability and usage at local, state and national levels
- calculate the volume of water held by tanks of various shapes and sizes
- investigate the costs of water usage at local, state and national levels, using published data.

FSRe2 Dams, land and catchment areas
In this topic, students perform a range of calculations involving scale, length, area and volume in relation to land and catchment areas and water storage. They learn to apply estimation methods in solving various problems involving area and volume.

**Students learn and acquire the following skills, knowledge and understanding:**
- calculate the scale used on a photograph given that it contains features with standard dimensions, eg an Olympic swimming pool
- calculate the perimeter of a section of land using a site plan or aerial photograph that includes a scale
• calculate the distance between two points on a section of land using online tools
• estimate the area of land and catchment areas
• calculate actual areas using scale diagrams
• calculate the volume of rainfall using $V = Ah$
• estimate the volume of a reservoir or dam using Simpson’s rule (up to two applications)

$$V = \frac{h}{3} \times \{\text{Area}_{\text{left end}} + 4 \times \text{Area}_{\text{middle}} + \text{Area}_{\text{right end}}\}$$

**FSRe3 Energy and sustainability**

The principal focus of this topic is the calculation and comparison of household electricity consumption and costs, and the calculation and interpretation of related statistics.

**Students learn and acquire the following skills, knowledge and understanding:**

• interpret information about a household’s electricity usage, eg a household electricity bill
• rank common appliances and physical activities in terms of their energy consumption in watts
• describe the watt-hour and kilowatt-hour as units of energy usage
• calculate the cost of running different household appliances for various time periods, given the power rating, usage time, and cost of power
• perform calculations and conversions involving units related to power, eg watt, watt-hour
• interpret the energy rating of appliances and compare running costs of different models of the same type of appliance
• calculate and interpret summary statistics for electricity costs, production data and consumption data at local, state, national and international levels
• investigate local council requirements for energy-efficient housing
• calculate building sustainability measures based on the requirements of the Building Sustainability Index (BASIX) Certificate
• identify the issues addressed in the BASIX, eg area of site, water, thermal comfort and energy.
### Dungog High School Mathematics Faculty
### Teaching Program Timeline
#### Year 12 General 2 Mathematics Course 2015-2016

#### Term 4 15

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
<th>Week 9</th>
<th>Week 10</th>
<th>Week 11</th>
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<tr>
<td><strong>Preliminary Work</strong></td>
<td><strong>Equations and Linear Functions</strong></td>
<td><strong>Probability</strong></td>
<td><strong>Area &amp; Volume</strong></td>
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#### Term 1 16

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<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
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<th>Week 7</th>
<th>Week 8</th>
<th>Week 9</th>
<th>Week 10</th>
<th>Week 11</th>
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<tbody>
<tr>
<td><strong>(No Students)</strong></td>
<td><strong>Non-Linear Relationships</strong></td>
<td><strong>Loans and Annuities</strong></td>
<td><strong>Geometry of the Earth</strong></td>
<td><strong>Half Yearly (Test 2)</strong></td>
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#### Term 2 16

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<th>Week 10</th>
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<tr>
<td><strong>Statistical Distribution</strong></td>
<td><strong>Sampling and Normal Distribution</strong></td>
<td><strong>Sine and Cosine Rule</strong></td>
<td><strong>Health and Medicine (Focus Study)</strong></td>
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#### Term 3 16

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<th>Week 8</th>
<th>Week 9</th>
<th>Week 10</th>
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</thead>
<tbody>
<tr>
<td><strong>Energy and Sustainability, Water Usage (Focus Study)</strong></td>
<td><strong>Trial HSC (Test 5)</strong></td>
<td><strong>Revision</strong></td>
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*Note: The position of the tests on this timeline, are only suggestive. Actual written notification will be given to every student at least 2 weeks prior to the assessment task.*
### HSC ASSESSMENT GRID
**Subject: General 2 Mathematics**

<table>
<thead>
<tr>
<th>Syllabus Components</th>
<th>Syllabus Weighting (%)</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
<th>Test 5</th>
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<tbody>
<tr>
<td></td>
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<td>Term 1, 2016</td>
<td>Term 2, 2016</td>
<td>Term 3, 2016</td>
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<tr>
<td>Concepts, Skills and Techniques</td>
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<td>Reasoning and Communication</td>
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<td><strong>Weighting Totals</strong></td>
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(Note: The dates of tasks are flexible) This table should be read in conjunction with the above table and the General Mathematics Timeline.

<table>
<thead>
<tr>
<th>Test</th>
<th>Topics</th>
<th>Weighting (%)</th>
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<tbody>
<tr>
<td>1</td>
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<td></td>
<td>Recall of Previous topics</td>
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<tr>
<td></td>
<td>Test 2 Corrections</td>
<td>3</td>
</tr>
<tr>
<td>2 (Half Yearly)</td>
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</tr>
<tr>
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<td>Health and Medicine</td>
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<tr>
<td></td>
<td>Test 3 Corrections</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Energy and Sustainability, Water Usage</td>
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</table>

-22-
MATHEMATICS

HSC Board of Studies Outcomes

H1 Seeks to apply mathematical techniques to problems in a wide range of practical contexts.
H2 Constructs arguments to prove and justify results.
H3 Manipulates algebraic expressions involving logarithmic and exponential functions.
H4 Expresses practical problems in mathematical terms based on simple given models.
H5 Applies appropriate techniques from the study of calculus, geometry, probability, trigonometry and series to solve problems.
H6 Uses the derivative to determine the features of the graph of a function.
H7 Uses the features of a graph to deduce information about the derivative.
H8 Uses techniques of integration to calculate areas and volumes.
H9 Communicates using mathematical language, notation, diagrams and graphs.

HSC Course Content

There are 8 topics covered in this course:

- Coordinate methods in geometry
- Geometrical applications of differentiation
- Integration
- Trigonometric functions (including applications of trigonometric ratios)
- Logarithmic and exponential functions
- Applications of calculus to the physical world
- Probability
- Series and series applications

See Extension 1 Mathematics Course Content for break down of topics.
### Term 4 15

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
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<th>Week 11</th>
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### Term 1 16

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<th>Week 11</th>
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<td>Applications of Calculus to the Physical World</td>
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**Note:** The position of the tests on this timeline are only suggestive. Actual written notification will be given to every student at least 2 weeks prior to the assessment task.
## HSC ASSESSMENT GRID

### SUBJECT: MATHEMATICS

<table>
<thead>
<tr>
<th>Syllabus Components</th>
<th>Syllabus Weighting (%)</th>
<th>Test 1 Term 4, 2015</th>
<th>Test 2 Term 1, 2016</th>
<th>Test 3 Term 2, 2016</th>
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### Nature of Assessment Task

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This table should be read in conjunction with the above table and the Mathematics Timeline.

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<td>Logs and Exponential Functions</td>
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<td>Test 2 Corrections</td>
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<td>(Half Yearly)</td>
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<td></td>
<td>Applications of Calculus</td>
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<td></td>
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<td>4</td>
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<td>(Trial HSC)</td>
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</table>
EXTENSION 1 MATHEMATICS

HSC Board of Studies Outcomes

HE1  Appreciates interrelationships between ideas drawn from different areas of mathematics.

HE2  Uses inductive reasoning in the construction of proofs.

HE3  Uses a variety of strategies to investigate mathematical models of situations involving binomial probability, projectiles, simple harmonic motion, or exponential growth and decay.

HE4  Uses the relationship between functions, inverse functions and their derivatives.

HE5  Applies the chain rule to problems including those involving velocity and acceleration as functions of displacement.

HE6  Determines integrals by reduction to a standard form through a given substitution.

HE7  Evaluates mathematical solutions to problems and communicates them in an appropriate form.

HSC Course Content

There are 11 topics covered in this course:

- Methods of integration including Primitive of \( \sin^2 x \) and \( \cos^2 x \)
- Rates of Change
- Velocity & acceleration as a function of \( x \)
- Projectile motion
- Simple harmonic motion
- Inverse functions and inverse trigonometric functions
- Induction
- Binomial theorem
- Further probability
- Iterative methods for numerical estimation of the roots of a polynomial equation
- Harder applications of HSC Mathematics questions

Explanation of symbols

†: denotes that students are not required to reproduce proofs of results contained in items preceded by this symbol.

E: denotes that the following item or items are not included in the mathematics course but are in the extension course.

Geometrical Applications of Differentiation

- Significance of the sign of the derivative.
- Stationary points on curves.

- The second derivative. The notations \( f''(x) \), \( \frac{d^2 y}{dx^2} \), \( y'' \).

- Geometrical significance of the second derivative.
- The sketching of simple curves.
- Problems on maxima and minima.
- Tangents and normals to curves.
- The primitive function and its geometrical interpretation.

Binomial Theorem

- (E) Expansion of \( (1 + x)^n \) for \( n = 2,3,4,\ldots \) Pascal Triangle. Proof of the Pascal Triangle relations. Extension to the expansion \( (a + x)^n \).

- (E,†) Proof by Mathematical Induction of the formula for \( ^nC_k \) (also denoted by \( \binom{n}{k} \)).
• (E) Finite series and further properties of binomial coefficients.

Integration
• (†) The definite integral.
• (†) The relation between the integral and the primitive function.
• (†) Approximate methods: trapezoidal rule and Simpson’s rule.
• Applications of integration: areas and volumes of solids of revolution.
• (E) Methods of integration, including reduction to standard forms by very simple substitutions.

Polynomials
• (E) Iterative methods for numerical estimation of the roots of a polynomial equation.

The Trigonometric Functions
• Circular measure of angles. Angle, arc, sector.
• The functions \(\sin x\), \(\cos x\), \(\tan x\), \(\cosec x\), \(\sec x\), \(\cot x\) and their graphs.
• Periodicity and other simple properties of the functions \(\sin x\), \(\cos x\) and \(\tan x\).
• Approximations to \(\sin x\), \(\cos x\), \(\tan x\), when \(x\) is small. The result \(\lim_{x \to 0} \frac{\sin x}{x} = 1\).
• (†) Differentiation of \(\cos x\), \(\sin x\), \(\tan x\).
• Primitive functions of \(\sin x\), \(\cos x\), \(\sec^2 x\).
• (E) Primitive functions of \(\sin^2 x\) and \(\cos^2 x\).
• Extension of points 2 to 6 to functions of the form \(a \sin(bx + c)\), etc.

Inverse Functions and the Inverse Trigonometric Functions
• (E) Discussion of inverse function. The functions \(y = \log_a x\) and \(y = a^x\) as inverse functions. The relation \(\frac{dy}{dx} \cdot \frac{dx}{dy} = 1\).
• (E) The inverse trigonometric functions.
• (E) The graphs of \(\sin^{-1} x\), \(\cos^{-1} x\), \(\tan^{-1} x\).
• (E) Simple properties of the inverse trigonometric functions.
• (E) The derivatives of \(\sin^{-1} \left(\frac{x}{a}\right)\), \(\cos^{-1} \left(\frac{x}{a}\right)\), \(\tan^{-1} \left(\frac{x}{a}\right)\), and the corresponding integrations.

Probability
• Random experiments, equally likely outcomes; probability of a given result.
• Sum and product of results.
• Experiments involving successive outcomes; tree diagrams.

Logarithmic and Exponential Functions
• Review of index laws, and definition of \(a^r\) for \(a > 0\), where \(r\) is rational.
• (†) Definition of logarithm to the base \(a\). Algebraic properties of logarithms and exponents.
• (†) The functions \(y = a^x\) and \(y = \log_a x\) for \(a > 0\) and real \(x\). Change of base.
• (†) The derivatives of \(y = a^x\) and \(y = \log_a x\). Natural logarithms and exponential function.
• Differentiation and integration of simple composite functions involving exponentials and logarithms.

Applications of Calculus to the Physical World
• Rates of change as derivatives with respect to time. The notation \(\dot{x}\), \(\ddot{x}\), etc.
• (†) Exponential growth and decay; rate of change of population; the equation \(\frac{dN}{dt} = kN\), where \(k\) is the population growth constant.
• (E) The equation \(= k (N - P)\), where \(k\) is the population growth constant, and \(P\) is a population constant.
• Velocity and acceleration as time derivatives. Applications involving:
  - the determination of the velocity and acceleration of a particle given its distance from a point as a function of time;
- the determination of the distance of a particle from a given point, given its acceleration or velocity as a function of time together with appropriate initial conditions.
- (E) Velocity and acceleration as functions of $x$.
- (E) Applications in one and two dimensions (projectiles).
- (E) Description of simple harmonic motion from the equation $x = a \cos (nt + \theta)$, $a > 0$, $n > 0$. The differential equation of the motion.

**Series and Applications**

* Arithmetic series. Formulae for the $n$th term and sum of $n$ terms.
* Geometric series. Formulae for the $n$th term and sum of $n$ terms.
* Geometric series with a ratio between $-1$ and $1$. The limit of $x^n$, as $n \to \infty$, for $|x| < 1$, and the concept of limiting sum for a geometric series.
* Applications of arithmetic series. Applications of geometric series: compound interest, simplified hire purchase and repayment problems. Applications to recurring decimals
### Term 4 15

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
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<th>Week 5</th>
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### Term 1 16

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<tbody>
<tr>
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### Term 2 16

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<td>Velocity and Acceleration as a function of x</td>
<td>Simple Harmonic Motion</td>
<td>Projectile Motion</td>
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### Term 3 16

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## HSC ASSESSMENT GRID
### SUBJECT: MATHEMATICS EXTENSION 1

<table>
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<tr>
<td>1</td>
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EXTENSION 2 MATHEMATICS

HSC Board of Studies Outcomes

E1 Appreciates the creativity, power and usefulness of mathematics to solve a broad range of problems.

E2 Chooses appropriate strategies to construct arguments and proofs in both concrete and abstract settings.

E3 Uses the relationship between algebraic and geometric representations of complex numbers and of conic sections.

E4 Uses efficient techniques for the algebraic manipulation required in dealing with questions such as those involving conic sections and polynomials.

E5 Uses ideas and techniques from calculus to solve problems in mechanics involving resolution of forces, resisted motion and circular motion.

E6 Combines the ideas of algebra and calculus to determine the important features of the graphs of a wide variety of functions.

E7 Uses the techniques of slicing and cylindrical shells to determine volumes.

E8 Applies further techniques of integration, including partial fractions, integration by parts and recurrence formulae, to problems.

E9 Communicates abstract ideas and relationships using appropriate notation and logical argument.

HSC Course Content

There are 8 topics covered in this course:

- Graphs
- Complex Numbers
- Conics
- Integration
- Volumes
- Mechanics
- Polynomials
- Harder Extension 1 topics

Graphs

Basic Curves
- graph a linear function \((ax + by + c = 0, y = mx + b)\)
- graph a quadratic function \((y = ax^2 + bx + c)\)
- graph a cubic function \((y = ax^3 + bx^2 + cx + d)\)
- graph a quartic function \((y = ax^4 + bx^3 + cx^2 + dx + e)\)
- graph a rectangular hyperbola \((xy = k)\)
- graph a circle \((x^2 + y^2 + 2gx + 2fy + c = 0)\)
- graph an exponential function \((y = a^x \text{ for both cases } a > 1 \text{ and } 0 < a < 1)\)
- graph a logarithmic function \((y = \log_a x)\)
- graph trigonometric functions (eg \(y = k + a \sin(bx + c)\))
- graph inverse trigonometric functions (eg \(y = a \sin^{-1} bx\))
- graph the functions \(y = x^{\frac{1}{2}}\) and \(y = x^{\frac{1}{3}}\).

Drawing graphs by addition and subtraction of ordinates
- graph a function \(y = f(x) \pm c\) by initially graphing \(y = f(x)\)
- graph a function \(y = f(x) \pm g(x)\) by initially graphing \(y = f(x)\) and \(y = g(x)\).
Drawing graphs by reflecting functions in coordinate axes
• graph \( y = -f(x) \) by initially graphing \( y = f(x) \)
• graph \( y = |f(x)| \) from the graph of \( y = f(x) \)
• graph \( y = f(-x) \) by initially graphing \( y = f(x) \).

Sketching functions by multiplication of ordinates
• graph a function \( y = cf(x) \) by initially graphing \( y = f(x) \)
• graph a function \( y = f(x) \cdot g(x) \) by initially graphing \( y = f(x) \) and \( y = g(x) \).

Sketching functions by division of ordinates
• graph a function \( y = 1/f(x) \) by initially graphing \( y = f(x) \)
• graph a function \( y = f(x)/g(x) \) by initially graphing \( y = f(x) \) and \( y = g(x) \).

Drawing graphs of the form \([f(x)]^n\)
• graph a function \( y = [f(x)]^n \) by first graphing \( y = f(x) \).

Drawing graphs of the form \( \sqrt{f(x)} \)
• graph a function \( y = \sqrt{f(x)} \) by first graphing \( y = f(x) \).

General approach to curve sketching
• use implicit differentiation to compute \( \frac{dy}{dx} \) for curves given in implicit form
• use the most appropriate method to graph a given function or curve.

Using graphs
• solve an inequality by sketching an appropriate graph
• find the number of solutions of an equation by graphical considerations
• solve problems using graphs.

Complex Numbers
Arithmetic of complex numbers and solving quadratic equations
• appreciate the necessity of introducing the symbol \( i \), where \( i^2 = -1 \), in order to solve quadratic equations
• write down the real part \( \text{Re}(z) \) and the imaginary part \( \text{Im}(z) \) of a complex number \( z = x + iy \).
• add, subtract and multiply complex numbers written in the form \( x + iy \)
• find the complex conjugate \( \overline{z} \) of the number \( z = x + iy \)
• divide a complex number \( a + ib \) by a complex number \( c + id \)
• write down the condition for \( a + ib \) and \( c + id \) to be equal
• prove that there are always two square roots of a non-zero complex number
• find the square roots of a complex number \( a + ib \)
• solve quadratic equations of the form \( ax^2 + bx + c = 0 \), where \( a, b, c \) are complex.

Geometric representation of a complex number as a point
• appreciate that there exists a one to one correspondence between the complex number \( a + ib \) and the ordered pair \((a,b)\)
• plot the point corresponding to \( a + ib \) on an Argand diagram
• define the modulus \( |z| \) and argument \( \text{arg}(z) \) of a complex number \( z \)
• find the modulus and argument of a complex number
• write \( a + ib \) in modulus-argument form
• prove basic relations involving modulus and argument
• use modulus-argument relations to do calculations involving complex numbers.
• recognise the geometrical relationships between the point representing \( z \) and points representing \( |z|, cz \) (where \( c \) is real) and \( iz \).
Geometrical representations of a complex number as a vector
• appreciate that a complex number $z$ can be represented as a vector on an Argand diagram
• appreciate the geometrical significance of the addition of two complex numbers
• given the points representing $z_1$ and $z_2$, find the position of the point representing $z$, where $z = z_1 + z_2$
• appreciate that the vector representing $z = z_1 + z_2$ corresponds to the diagonal of a parallelogram with vectors representing $z_1$ and $z_2$ as adjacent sides
• given vectors $z_1$ and $z_2$, construct vectors $z_1 - z_2$ and $z_2 - z_1$
• given $z_1$ and $z_2$, construct the vector $z_1 z_2$
• prove geometrically that $|z_1 + z_2| \leq |z_1| + |z_2|

Powers and roots of complex numbers
• prove, by induction, that $(\cos \theta + i \sin \theta)^n = \cos n\theta + i \sin n\theta$ for positive integers $n$
• prove that $(\cos \theta + i \sin \theta)^n = \cos n\theta + i \sin n\theta$ for negative integers $n$
• find any integer power of a given complex number
• find the complex $n^{th}$ roots of $\pm 1$ in modulus-argument form
• sketch the $n$th roots of $\pm 1$ on an Argand diagram
• illustrate the geometrical relationship connecting the $n^{th}$ roots of $\pm 1$.

Curves and Regions
• given equations $\text{Re}(z) = c$, $\text{Im}(z) = k$ ($c$, $k$ real), sketch lines parallel to the appropriate axis
• given an equation $|z - z_1| = |z - z_2|$ sketch the corresponding line
• given equations $|z| = R$, $|z - z_1| = R$, sketch the corresponding circles
• given equations $\arg z = \theta$, $\arg(z - z_1) = \theta$, sketch the corresponding rays
• sketch regions associated with any of the above curves (eg the region corresponding to those $z$ satisfying the inequality $|z - z_1| \leq R$)
• give a geometrical description of any such curves or regions
• sketch and describe geometrically the intersection and/or union of such regions
• sketch and give a geometrical description of other simple curves and regions.

Conics
The Ellipse
• write down the defining equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ of an ellipse with centre the origin
• sketch the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, showing points of intersection with axes of symmetry
• find the lengths of the major and minor axes and semi-major and semi-minor axes of an ellipse
• write down the parametric coordinates $(a \cos \theta, b \sin \theta)$ of a point on an ellipse
• sketch an ellipse using its auxiliary circle
• find the equation of an ellipse from its focus-directrix definition
• find the eccentricity from the defining equation of an ellipse
• given the equation of an ellipse, find the coordinates of the foci and equations of the directrices
• sketch an ellipse, marking on the sketch the positions of its foci and directrices
• use implicit differentiation to find the equations of the tangent and the normal at $P(x_1, y_1)$ on an ellipse
• find the equations of the tangent and the normal at $P(a \cos \theta, b \sin \theta)$ on an ellipse
• find the equation of a chord of an ellipse
• find the equation of a chord of contact
• prove that the sum of the focal lengths is constant
• prove the reflection property, namely that the tangent to an ellipse at a point $P$ on it is equally inclined to the focal chords through $P$
• prove that the chord of contact from a point on a directrix is a focal chord.
• prove that the part of the tangent between the point of contact and the directrix subtends a right angle at the corresponding focus
• prove simple properties for both general ellipse \( \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \) and for ellipses with given values of \( a \) & \( b \).

The Hyperbola

• write down the defining equation \( \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \) of a hyperbola with centre the origin

• sketch the hyperbola \( \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \), showing points of intersection with axes of symmetry and positions of asymptotes

• find the length of major and minor axes and semi-major and semi-minor axes of a hyperbola

• write down the parametric coordinates \((a \sec \theta, b \tan \theta)\) of a point on the hyperbola

• find the equation of a hyperbola from its focus-directrix definition

• find the eccentricity from the defining equation of a hyperbola

• given the equation of the hyperbola, find the coordinates of its foci and equations of its directrices

• sketch a hyperbola, marking on the positions of its foci and directrices

• use implicit differentiation to find the equations of the tangent and the normal at \( P(x_1, y_1) \) on a hyperbola

• find the equations of the tangent and the normal at \( P(a \sec \theta, b \tan \theta) \) on the hyperbola

• find the equation of a chord of a hyperbola

• find the equation of a chord of contact

• prove that the difference of the focal lengths is constant

• prove the reflection property for a hyperbola

• prove that the chord of contact from a point on the directrix is a focal chord

• prove simple properties for both the general hyperbola \( \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \) and for hyperbolae with given values of \( a \) and \( b \).

The Rectangular Hyperbola

• prove that the hyperbola with equation \( xy = \frac{1}{2} a^2 \) is the hyperbola \( x^2 - y^2 = a^2 \) referred to different axes

• write down the eccentricity, coordinates of foci and vertices, equations of directrices and equations of asymptotes of \( xy = \frac{1}{2} a^2 \)

• sketch the hyperbola \( xy = \frac{1}{2} a^2 \), for values of \( a \), marking on vertices, foci, directrices and asymptotes

• write down the parametric coordinates \((ct, \frac{c}{t})\) for the rectangular hyperbola \( xy = c^2 \), for varying values of \( c \)

• find the equation of the chord joining \( P(cp, \frac{c}{p}) \) to \( Q(cq, \frac{c}{q}) \)

• find the equation of the tangent at \( P(cp, \frac{c}{p}) \)

• find the equation of the normal at \( P(cp, \frac{c}{p}) \)

• find the equation of the chord joining \( P(x_1,y_1) \) to \( Q(x_2, y_2) \)

• find the equation of the chord of contact from \( T(x_0, y_0) \)

• find the point of intersection of tangents and of normals

• prove simple geometrical properties of the rectangular hyperbola including:
  – the area of the triangle bounded by a tangent and the asymptotes is a constant
  – the length of the intercept, cut off a tangent by the asymptotes, equals twice the distance of the point of contact from the intersection of the asymptotes

• find loci of points including:
  – loci determined by intersection points of tangents
– loci determined by intersection points of normals
– loci determined by midpoints of intervals.

**General descriptive properties of conics**

- appreciate that the various conic sections (circle, ellipse, parabola, hyperbola and pairs of intersecting lines) are indeed the curves obtained when a plane intersects a (double) cone
- relate the various ranges of values of the eccentricity e to the appropriate conic and to understand how the shape of a conic varies as its eccentricity varies
- appreciate that the equations of all conic sections involve only quadratic expressions in x and y.

**Integration**

**Integration**

- use a table of standard integrals
- change an integrand into an appropriate form by use of algebra
- evaluate integrals using algebraic substitutions
- evaluate simple trigonometric integrals
- evaluate integrals using trigonometric substitutions
- evaluate integrals using integration by parts
- derive and use recurrence relations
- integrate rational functions by completing the square in a quadratic denominator
- integrate rational functions whose denominators have simple linear or quadratic factors.

**Volumes**

**Volumes**

- appreciate that, by dividing a solid into a number of slices or shells, whose volumes can be simply estimated, the volume of the solid is the value of the definite integral obtained as the limit of the corresponding approximating sums
- find the volume of a solid of revolution by summing the volumes of slices with circular cross-sections
- find the volume of a solid of revolution by summing the volumes of slices with annular cross-sections
- find the volume of a solid of revolution by summing the volumes of cylindrical shells
- find the volume of a solid which has parallel cross-sections of similar shapes.

**Mechanics**

**Mathematical Representation of a motion described in physical terms**

- derive the equations of motion of a projectile
- use equations for horizontal and vertical components of velocity and displacement to answer harder problems on projectiles
- write down equations for displacement, velocity and acceleration given that a motion is simple harmonic
- use relevant formulae and graphs to solve harder problems on simple harmonic motion
- use Newton’s laws to obtain equations of motion of a particle in situations other than projectile motion and simple harmonic motion
- describe mathematically the motion of particles in situations other than projectile motion and simple harmonic motion.

**Physical explanations of mathematical descriptions of motion**

- given $\ddot{x} = f(x)$ and initial conditions derive $v^2 = g(x)$ and describe the resultant motion
- recognise that a motion is simple harmonic, given an equation for either acceleration, velocity or displacement, and describe the resultant motion.

**Resisted motion**

**Resisted Motion along a horizontal line**

- derive, from Newton’s laws of motion, the equation of motion of a particle moving in a single direction under a resistance proportional to a power of the speed
- derive an expression for velocity as a function of time (where possible)
- derive an expression for velocity as a function of displacement (where possible)
- derive an expression for displacement as a function of time (where possible).
Motion of a particle moving upwards in a resisting medium and under the influence of gravity
• derive, from Newton’s laws of motion, the equation of motion of a particle, moving vertically upwards in a medium, with a resistance $R$ proportional to the first or second power of its speed
• derive expressions for velocity as a function of time and for velocity as a function of displacement (or vice versa)
• derive an expression for displacement as a function of time
• solve problems by using the expressions derived for acceleration, velocity and displacement.

Motion of a particle falling downwards in a resisting medium and under the influence of gravity
• derive, from Newton’s laws of motion, the equation of motion of a particle falling in a medium with a resistance $R$ proportional to the first or second power of its speed
• determine the terminal velocity of a falling particle, from its equation of motion
• derive expressions for velocity as a function of time and for velocity as a function of displacement
• derive an expression for displacement as a function of time
• solve problems by using the expressions derived for acceleration, velocity and displacement.

Circular Motion
Motion of a particle around a circle
• define the angular velocity of a point moving about a fixed point
• deduce, from this definition of angular velocity, expressions for angular acceleration of a point about a fixed point
• prove the instantaneous velocity of a particle moving in a circle of radius $R$, with angular velocity $\omega$, is $R\omega$
• prove that the tangential and normal components of the force acting on a particle moving in a circle of radius $R$, with angular velocity $\omega$, need to be $Mr\dot{\omega}$ and $-mR\omega^2$ respectively.

Motion of a particle moving with uniform angular velocity around a circle
• write down the formulae appropriate for a particle moving around a circle with uniform angular velocity
• apply these formulae to the solution of simple problems.

The Conical Pendulum
• use Newton’s law to analyse the forces acting on the bob of a conical pendulum
• derive results including $\tan \theta = \frac{v^2}{ag}$ and $h = \frac{g}{\omega^2}$
• discuss the behaviour of the pendulum as its features vary
• apply derived formulae to the solution of simple problems.

Motion around a banked circular track
• Use Newton’s laws to analyse the forces acting on a body, represented by a particle, moving at constant speed around a banked circular track
• derive the results $\tan \theta = \frac{v^2}{Rg}$ and $h = \frac{v^2d}{Rg}$
• calculate the optimum speed around a banked track given the construction specifications
• calculate the forces acting on a body, travelling around a banked track, at a speed other than the optimum speed.

Polynomials
Integer roots of polynomials with integer coefficients
• prove that, if a polynomial has integer coefficients and if $a$ is an integer root, then $a$ is a divisor of the constant term
• test a given polynomial with integer coefficients for possible integer roots

Multiple Roots
• define a multiple root of a polynomial
• write down the order (multiplicity) of a root
• prove that if $P(x) = (x - a)^r S(x)$, where $r > 1$ and $S(a) \neq 0$, then $P'(x)$ has a root $a$ of multiplicity $(r-1)$
• solve simple problems involving multiple roots of a polynomial.
Fundamental Theorem of Algebra
- state the fundamental theorem of algebra
- deduce that a polynomial of degree \( n > 0 \), with real or complex coefficients, has exactly \( n \) complex roots, allowing for multiplicities.

Factoring Polynomials
- recognise that a complex polynomial of degree \( n \) can be written as a product of \( n \) complex linear factors
- recognise that a real polynomial of degree \( n \) can be written as a product of real linear and real quadratic factors
- factor a real polynomial into a product of real linear and real quadratic factors
- factor a polynomial into a product of complex linear factors
- write down a polynomial given a set of properties sufficient to define it
- solve polynomial equations over the real and complex numbers.

Roots and Coefficients of a Polynomial Equation
- write down the relationships between the roots and coefficients of polynomial equations of deg 2, 3 and 4.
- use these relationships to form a polynomial equation given its roots
- form an equation, whose roots are a multiple of the roots of a given equation
- form an equation, whose roots are the reciprocals of the roots of a given equation
- form an equation, whose roots differ by a constant from the roots of a given equation
- form an equation, whose roots are the squares of the roots of a given equation.

Partial Fractions
- write \( f(x) = \frac{A(x)}{B(x)} \), where \( \deg A(x) \geq \deg B(x) \), in the form \( f(x) = \frac{Q(x)}{B(x)} + R(x)/B(x) \), where \( \deg R(x) < \deg B(x) \)
- write \( \frac{R(x)}{B(x)} \), where \( \deg R(x) < \deg B(x) \) and \( B(x) \) is a product of distinct linear factors \( c(x - a_1) \ldots (x - a_n) \), in the form \( \frac{c_1}{x - a_1} + \ldots + \frac{c_n}{x - a_n} \)
- write \( \frac{R(x)}{B(x)} \), where \( \deg R(x) < \deg B(x) \) and \( B(x) \) is a product of distinct linear factors and a simple quadratic factor, in the form \( \frac{c_1}{x - a_1} + \ldots + \frac{c_n}{x - a_n} + \frac{dx + e}{x^2 + bx + c} \)
- write \( \frac{R(x)}{B(x)} \), where \( \deg R(x) < \deg B(x) \) and \( B(x) \) is a product of two different simple quadratic factors of form \( x^2 + b_1 \), in the form \( \frac{c_1 x + d_1}{x^2 + b_1} + \frac{c_2 x + d_2}{x^2 + b_2} \)
- apply these partial fraction decompositions to the integration of corresponding functions.

Harder Ext 1 Mathematics

Geometry of the Circle
- solve more difficult problems in geometry.

Induction
- carry out proofs by mathematical induction in which \( S(1), S(2) \ldots S(k) \) are assumed to be true in order to prove \( S(k + 1) \) is true
- use mathematical induction to prove results in topics which include geometry, inequalities, sequences and series, calculus and algebra.

Inequalities
- prove simple inequalities by use of the definition of \( a > b \) for real \( a \) and \( b \)
- prove further results involving inequalities by logical use of previously obtained inequalities.
**Dungog High School Mathematics Faculty Teaching Program Timeline Year 12 Ext 2 Mathematics Course 2015-2016**

### Term 4 15

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
<th>Week 9</th>
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<th>Week 5</th>
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<th>Week 7</th>
<th>Week 8</th>
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<td>Graphs</td>
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### Term 2 16

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<th>Week 6</th>
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<td>Trial HSC (Test 5)</td>
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<td>Revision including Harder Ext 1 Topics</td>
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**Note:** The position of the tests on this timeline are only suggestive. Actual written notification will be given to every student at least 2 weeks prior to the assessment task.
## HSC ASSESSMENT GRID
**Subject: Mathematics Extension 2**

<table>
<thead>
<tr>
<th>Syllabus Components</th>
<th>Syllabus Weighting (%)</th>
<th>Task 1</th>
<th>Task 2</th>
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<th>Task 5</th>
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### Weighting Totals

| Weighting Totals | 100 | 21 | 30 | 21 | 9 | 19 |

Note: The dates of tasks are flexible.

This table should be read in conjunction with the above table and the Extension 2 Timeline.

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<thead>
<tr>
<th>Test</th>
<th>Topics</th>
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<td>5 (Trial HSC)</td>
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