CCEA A2 Mathematics & Further Mathematics

Teaching Schedules

Updated August 2020

These schedules are based upon shared teaching with equal times for each of 2 teachers.

Please note that this teaching order should be followed by all teachers.

They will allow either consecutive or parallel teaching of A2 Mathematics and Further Mathematics.

Mathematics

This schedule is designed to cover all of Unit 1 first, then followed by Unit 2A and Unit 2B.

Further Mathematics

These schedules are designed to cover all of Unit 1 first, then followed by each of the other two Applied units.

A2 Mathematics

Week	Teacher 1	Teacher 2

1	**Partial Fractions**
	• Simplify rational expressions by factorising, cancelling and algebraic division
	• Decompose rational functions into partial fractions
		Trigonometry
		• Radian measure
		• Arc length and sector area
		• Definitions of secant, cosecant, cotangent
		• Definitions of arcsin, arccos and arctan
		• Graphs of each function, including domains and ranges
		• Use of
		  ○ $\sec^2\theta = 1 + \tan^2\theta$
		  ○ $\operatorname{cosec}^2\theta = 1 + \cot^2\theta$
		• Compound angle formulae for sine, cosine and tangent
		• Double angle formulae
		• Harmonic form
		• Construct proofs involving trig functions and identities
		• Use of trig functions to solve problems in context

2 3 4 5	**Differentiation (i)** • Differentiation of exponential, logarithmic and trig functions and their related sums, differences and constant multiples • Chain rule • Product rule • Quotient rule	

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	Integration
	• Integrate e^{kx}, $\frac{1}{x}$, $\sin kx$, $\cos kx$ and related functions
	• Area between 2 curves
	• Integration using
	  ○ Substitution
	  ○ Parts
	  ○ Partial fractions
	• Volumes of revolution
		Sequences and Series
		• Simple sequences, including recurrence relations
		• Convergence, divergence and oscillation
		• Use of sigma notation for series
		• Arithmetic Progressions
		• Geometric Progressions

10	**Parametric Equations** • Use parametric equations of curves • Convert between parametric and Cartesian forms	
11 12	**Differentiation(ii)** • Differentiation of simple functions defined implicitly or parametrically • To include second derivatives	**Binomial** • Expansion of $(a + bx)^n$ for any rational n • Knowledge of range of validity
13 14	**Differential Equations** • Construct and solve simple differential equations • Interpret solution and identify limitations	**Functions** • Definition and terminology • Composite function • Inverse functions and graphs • Modulus function
15 16	**Numerical Methods** • Use of trapezium rule as an approximation to the area under a curve • Location of roots • Newton-Raphson method	**Graph Transformations** Combination of simple transformations

17
18
19
	Moments
	• Use moments in simple static contexts – to include
	  ○ Rods
	  ○ Ladders
	  ○ Hinged beams
		Kinematics and calculus
		• Motion in a straight line
		• Motion in two dimensions in vector form

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<tr><th>Week</th><th>Teacher 1</th><th>Teacher 2</th></tr>
<tr><td>20</td><td rowspan="2"><u>Impulse and Momentum</u>
Simple use of impulse and momentum
Conservation of linear momentum
Problems to involve direct collisions and explosions</td><td rowspan="2"><u>Projectiles</u>
Solve problems involving projectiles – may include vector format
Derive and use formulae for time of flight, range, equation of path of flight</td></tr>
<tr><td>21</td></tr>
<tr><td>22</td><td rowspan="2"><u>Normal distribution</u>
Use of the normal distribution as an example of a continuous probability distribution
Find probabilities using the normal distribution
Selection of an appropriate binomial/normal model for a specific context</td><td rowspan="4"><u>Hypothesis Testing</u>
Understand and use the language of hypothesis testing
Conduct a hypothesis test for
the proportion in the binomial distribution
the mean of a normal distribution
Interpret results of hypothesis test in context</td></tr>
<tr><td>23</td></tr>
<tr><td>24</td><td rowspan="2"><u>Probability</u>
Use of conditional probability – to include tree diagrams, Venn diagram and two-way tables
Use of the conditional probability formula
Solution of problems in context</td></tr>
<tr><td>25</td></tr>
<tr><td>26</td><td><u>Hypothesis Testing</u>
Interpret a correlation coefficient using a p-value or critical value</td></tr>
</table>

A2 Further Mathematics Units 1, 2A & 2B

<table>
<tr><th>Week</th><th>Teacher 1</th><th>Teacher 2</th></tr>
<tr><td>1
2</td><td rowspan="2"><u>Further Circular Motion</u>[1]
• Banked corners
• Sliding
• Overturning (some introductory work on Moments will be required)</td><td rowspan="2"><u>Polar Coordinates</u>
• Convert between polar and Cartesian coordinates
• Sketch curves with r given as function of θ
• Area enclosed by a polar curve</td></tr>
<tr><td>3</td><td rowspan="3"><u>Complex numbers</u>
• Use of De Moivre's Theorem to find
○ Multiple angle formulae
○ Sums of series
• Use of
○ $e^{i\theta} = \cos\theta + i\sin\theta$
○ $z = re^{i\theta}$
• Find nth roots of $re^{i\theta}$ and relate to Argand diagram
• Use complex roots of unity to solve geometric problems</td></tr>
<tr><td>4
5
6</td><td><u>Induction</u>
• Construction of proofs involving e.g.
○ Sums of series
○ Divisibility
○ Powers of matrices</td></tr>
<tr><td>7</td><td><u>Hyperbolic Functions</u>
• Definitions of $\sinh x$, $\cosh x$ and $\tanh x$, including domains, ranges and graphs
• Differentiate hyperbolic functions
• Integrate hyperbolic functions</td></tr>
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9</td><td>• Definitions of inverse hyperbolic functions, including domains and ranges
• Derive and use the logarithmic forms of the inverse hyperbolic functions</td><td><u>Simple Harmonic Motion</u>[2]
• Standard results
• Solution of SHM equation
• Simple pendulum
• Oscillations involving elastic strings</td></tr>
<tr><td>10
11
12
13
14</td><td><u>Further Calculus</u>
• Evaluate improper integrals
• Integration using partial fractions – to include quadratic factors in denominator
• Differentiate inverse trig functions
• Integrate functions of the form $(a^2 - x^2)^{-1/2}$ and $(a^2 + x^2)^{-1}$ and choose the appropriate trigonometric substitutions to integrate associated functions
• Integrate functions of the form $(x^2 + a^2)^{-1/2}$ and $(x^2 - a^2)^{-1/2}$ and choose the appropriate hyperbolic substitutions to integrate associated functions
• Repeated integration by parts
• Reduction formulae</td><td><u>Series</u>
• Decompose rational functions into partial fractions – to include quadratic factors in denominator
• Use of formulae for sums of integers, squares and cubes to find sums of other series
• Use method of differenced for summation of series – to include use of partial fractions
• Find the Maclaurin series of a function – to include the general term
• Recognise and use the Maclaurin series for e^x, $\ln(1+x)$, $\sin x$, $\cos x$ and $(1+x)^n$ – to include awareness of the range of values of x for which they are valid
• Derive the series expansions of simple compound functions
• Use of standard small angle approximations of sine, cosine and tangent</td></tr>
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[1] Unit 2A topic introduced at this stage to ensure all pre-requisite A2 Pure Maths is covered when teaching Further Maths in parallel. If not teaching in parallel, then this topic could be taught immediately after FM Unit 1 material.

[2] As above

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• System of particles
• Rods
• Simple laminae
• Composite laminae
• Suspended laminae</td></tr>
<tr><td>16</td><td rowspan="2"><u>Differential Equations</u>
• Use of integrating factor
• General and particular solutions
• Use of auxiliary equation to solve 2nd order homogeneous differential equations</td></tr>
<tr><td>17</td><td>• Solve 2nd order differential equations of the form $y'' + ay' + by = \mathrm{f}(x)$, where $\mathrm{f}(x)$, is
○ a polynomial function
○ an exponential function
○ a trigonometric function
○ not a solution of the corresponding homogeneous equation
○ Use the relationship between the case when the discriminant of the auxiliary equation is positive, zero and negative</td><td rowspan="2"><u>Frameworks</u>
• Light pin-jointed frameworks
• Bow's notation optional
• Thrusts/tensions</td></tr>
<tr><td>18</td><td rowspan="2"><u>Damped Oscillations</u>
• Use of 2nd order differential equations</td></tr>
<tr><td>19</td><td rowspan="2"><u>Further Centre of Mass</u>
• Laminae and solids
• Use of calculus
• Composite bodies
• Suspended bodies
• Sliding/toppling</td></tr>
<tr><td>20</td><td rowspan="3"><u>Force Systems</u>
• Resultant of a system of coplanar forces
• Replace force system by
○ A single force
○ A couple
○ A single force plus a couple</td></tr>
<tr><td>21</td></tr>
<tr><td>22</td><td rowspan="2"><u>Further Kinematics</u>
• Problems in 3 dimensions including use of calculus and vectors
• Problems where acceleration is given as function of time, velocity or displacement
• Examples involving constant power</td></tr>
<tr><td>23</td><td rowspan="2"><u>Restitution</u>
• Problems involving
○ Smooth sphere
○ Smooth sphere and fixed plane</td></tr>
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A2 Further Mathematics Units 1, 2A & 2C

Week	Teacher 1	Teacher 2
1	**Further Circular Motion**[3] • Banked corners • Sliding • Overturning (some introductory work on Moments will be required)	**Polar Coordinates** • Convert between polar and Cartesian coordinates • Sketch curves with r given as function of θ • Area enclosed by a polar curve
2		

3		**Complex numbers**
		• Use of De Moivre's Theorem to find
		  ○ Multiple angle formulae
		  ○ Sums of series
		• Use of
		  ○ $e^{i\theta} = \cos\theta + i\sin\theta$
		  ○ $z = re^{i\theta}$
		• Find nth roots of $re^{i\theta}$ and relate to Argand diagram
		• Use complex roots of unity to solve geometric problems

4	**Induction**
	• Construction of proofs involving e.g.
	  ○ Sums of series
	  ○ Divisibility
	  ○ Powers of matrices	

5		
6		
7	**Hyperbolic Functions** • Definitions of $\sinh x$, $\cosh x$ and $\tanh x$, including domains, ranges and graphs • Differentiate hyperbolic functions • Integrate hyperbolic functions	
8	• Definitions of inverse hyperbolic functions, including domains and ranges	**Simple Harmonic Motion**[4] • Standard results • Solution of SHM equation • Simple pendulum • Oscillations involving elastic strings
9	• Derive and use the logarithmic forms of the inverse hyperbolic functions	
10	**Further Calculus**	
11	• Evaluate improper integrals	**Series** • Decompose rational functions into partial fractions – to include quadratic factors in denominator • Use of formulae for sums of integers, squares and cubes to find sums of other series • Use method of differenced for summation of series – to include use of partial fractions • Find the Maclaurin series of a function – to include the general term • Recognise and use the Maclaurin series for e^x, $\ln(1+x)$, $\sin x$, $\cos x$ and $(1+x)^n$ – to include awareness of the range of values of x for which they are valid • Derive the series expansions of simple compound functions • Use of standard small angle approximations of sine, cosine and tangent
12	• Integration using partial fractions – to include quadratic factors in denominator	
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14	• Differentiate inverse trig functions • Integrate functions of the form $(a^2 - x^2)^{-1/2}$ and $(a^2 + x^2)^{-1}$ and choose the appropriate trigonometric substitutions to integrate associated functions • Integrate functions of the form $(x^2 + a^2)^{-1/2}$ and $(x^2 - a^2)^{-1/2}$ and choose the appropriate hyperbolic substitutions to integrate associated functions • Repeated integration by parts • Reduction formulae	

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• Use E($aX + bY$) and Var ($aX + bY$) where X and Y are independent random variables
• Solution of problems involving linear combinations of independent normally distributed variables</td></tr>
<tr><td>20</td><td rowspan="2"><u>Sampling and Estimation</u>
• Use of Central Limit Theorem
• Calculate point estimates of the population mean and variance
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<tr><td>22</td><td rowspan="3"><u>t – tests</u>
• Understanding of when to use the t-distribution
• Carry out a hypothesis test for the population mean
• Formulate a hypothesis and carry out a two-sample or paired- sample t-test for the difference of the sample means</td><td rowspan="3"><u>χ^2 tests</u>
• Fit a theoretical distribution to given data
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A2 Further Mathematics Units 1, 2A & 2D

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3		**Complex numbers**
		• Use of De Moivre's Theorem to find
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		  ○ $e^{i\theta} = \cos\theta + i\sin\theta$
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9	• Derive and use the logarithmic forms of the inverse hyperbolic functions	
10	**Further Calculus** • Evaluate improper integrals	**Series** • Decompose rational functions into partial fractions – to include quadratic factors in denominator
11	• Integration using partial fractions – to include quadratic factors in denominator	• Use of formulae for sums of integers, squares and cubes to find sums of other series
12	• Differentiate inverse trig functions	• Use method of differenced for summation of series – to include use of partial fractions
13	• Integrate functions of the form $(a^2 - x^2)^{-1/2}$ and $(a^2 + x^2)^{-1}$ and choose the appropriate trigonometric substitutions to integrate associated functions	• Find the Maclaurin series of a function – to include the general term
14	• Integrate functions of the form $(x^2 + a^2)^{-1/2}$ and $(x^2 - a^2)^{-1/2}$ and choose the appropriate hyperbolic substitutions to integrate associated functions • Repeated integration by parts • Reduction formulae	• Recognise and use the Maclaurin series for e^x, $\ln(1+x)$, $\sin x$, $\cos x$ and $(1+x)^n$ – to include awareness of the range of values of x for which they are valid • Derive the series expansions of simple compound functions • Use of standard small angle approximations of sine, cosine and tangent

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• Use of 2nd order differential equations</td><td rowspan="2"><u>Algorithms on Graphs</u>
• Nearest neighbour algorithm
• Solution of problems using PERT
• Two variable linear programming problems</td></tr>
<tr><td>19</td></tr>
<tr><td>20</td><td rowspan="2"><u>Graph Theory</u>
• Vertex and edge colouring
• Cutsets and max-flow min-cut theorem
• Bipartite graphs
• Hall's marriage theorem</td><td rowspan="2"><u>Counting</u>
• Principle of Inclusion and Exclusion
• Derangements
• Rook polynomials</td></tr>
<tr><td>21</td></tr>
<tr><td>22</td><td rowspan="3"><u>Group Theory</u>
• Symmetry groups – to include
○ Cyclic group C_n
○ Dihedral group D_{2n}
○ Symmetry groups of the cube, octahedron and tetrahedron
○ Concept of cycle index
○ Use of table of cycle indices for simple symmetry groups
○ Polya's Enumeration Theorem
○ Use of the pattern inventory for 2 colours and the similar result for 3 colours</td><td rowspan="3"><u>Generating Functions</u>
• Understating of a generating function
• Formulation of a generating function to solve simple summation problems
• Use combinatorial arguments and elementary generating functions to prove simple formulae</td></tr>
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A2 Further Mathematics Units 1, 2C & 2D

<table>
<tr><th>Week</th><th>Teacher 1</th><th>Teacher 2</th></tr>
<tr><td>1</td><td rowspan="4"><u>Group Theory</u>[7]
• Symmetry groups – to include
○ Cyclic group C_n
○ Dihedral group D_{2n}
○ Symmetry groups of the cube, octahedron and tetrahedron
○ Concept of cycle index
○ Use of table of cycle indices for simple symmetry groups
○ Polya's Enumeration Theorem
• Use of the pattern inventory for 2 colours and the similar result for 3 colours</td><td rowspan="2"><u>Polar Coordinates</u>
• Convert between polar and Cartesian coordinates
• Sketch curves with r given as function of θ
• Area enclosed by a polar curve</td></tr>
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• Use of De Moivre's Theorem to find
○ Multiple angle formulae
○ Sums of series
• Use of
○ $e^{i\theta} = \cos\theta + i\sin\theta$
○ $z = re^{i\theta}$
• Find nth roots of $re^{i\theta}$ and relate to Argand diagram
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• Construction of proofs involving e.g.
○ Sums of series
○ Divisibility
○ Powers of matrices</td></tr>
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<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="2"><u>Hyperbolic Functions</u>
• Definitions of $\sinh x$, $\cosh x$ and $\tanh x$, including domains, ranges and graphs
• Differentiate hyperbolic functions
• Integrate hyperbolic functions</td><td><u>Graph Theory</u>[8]
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• Decompose rational functions into partial fractions – to include quadratic factors in denominator
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• Evaluate improper integrals
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• Nearest neighbour algorithm
• Solution of problems using PERT
• Two variable linear programming problems</td></tr>
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Use of auxiliary equation to solve 2nd order homogeneous differential equations
Solve 2nd order differential equations of the form $y'' + ay' + by = \mathrm{f}(x)$, where $\mathrm{f}(x)$, is
a polynomial function
an exponential function
a trigonometric function
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Calculate point estimates of the population mean and variance
Use of standard error of the mean
Calculate confidence limits for the population mean</td></tr>
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Understanding of when to use the t-distribution
Carry out a hypothesis test for the population mean
Formulate a hypothesis and carry out a two-sample or paired- sample t-test for the difference of the sample means</td></tr>
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Use a χ^2 test with the appropriate number of degrees of freedom to carry out the corresponding goodness of fit test
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