COURSE OUTLINE
MATHEMATICS SPECIALIST– ATAR YEAR 12: 2021
UNIT 3 AND UNIT 4

Term	Week	Topic and key teaching points	Syllabus content	Assessment
1	1	**Complex Numbers** Cartesian Forms	3.1.1 review real and imaginary parts Re(z) and Im(z) of a complex number z 3.1.2 review Cartesian form 3.1.3 review complex arithmetic using Cartesian forms	
1	2	**Complex Numbers** Factorisation of polynomial	3.1.13 prove and apply the factor theorem and the remainder theorem for polynomials 3.1.14 consider conjugate roots for polynomials with real coefficients 3.1.15 solve simple polynomial equations	
1	3	**Complex Numbers** The complex plane (The Argand plane)	3.1.8 examine and use addition of complex numbers as vector addition in the complex plane 3.1.9 examine and use multiplication as a linear transformation in the complex plane 3.1.10 identify subsets of the complex plane determined by relations such as $\|z-3i\| \leq 4,\ \frac{\pi}{4} \leq Arg(z) \leq \frac{3\pi}{4}$ and $\|z-1\| = 2\|z-i\|$	
1	4-5	**Complex Numbers** Complex arithmetic using polar form Roots of complex numbers	3.1.4 use the modulus |z| of a complex number *z* and the argument Arg (z) of a non-zero complex number z and prove basic identities involving modulus and argument 3.1.5 convert between Cartesian and polar form 3.1.6 define and use multiplication, division, and powers of complex numbers in polar form and the geometric interpretation of these 3.1.7 prove and use De Moivre's theorem for integral powers 3.1.11 determine and examine the n^{th} roots of unity and their location on the unit circle 3.1.12 determine and examine the n^{th} roots of complex numbers and their location in the complex plane	Investigation 1 Out start Week 4 Due start of Week 6
1	6-7	**Functions and sketching graphs** Functions	3.2.1 determine when the composition of two functions is defined 3.2.2 determine the composition of two functions 3.2.3 determine if a function is one-to-one 3.2.4 find the inverse function of a one-to-one function 3.2.5 examine the reflection property of the graphs of a function and its inverse	Test 1 Week 7
1	8-9	**Functions and sketching graphs** Sketching graphs	3.2.6 use and apply $\|x\|$ for the absolute value of the real number *x* and the graph of $y=\|x\|$	

			3.2.7 examine the relationship between the graph of $y = f(x)$ and the graphs of $y = \frac{1}{f(x)}$, $y = \lvert f(x)\rvert$ and $y = f(\lvert x\rvert)$ 3.2.8 sketch the graphs of simple rational functions where the numerator and denominator are polynomials of low degree	
2	1	**Vectors** The algebra of vectors in three dimensions	3.3.1 review the concepts of vectors from Unit 1 and extend to three dimensions, including introducing the unit vectors **i, j** and **k** 3.3.2 prove geometric results in the plane and construct simple proofs in 3 dimensions	
2	2-3	**Vectors** Vectors and Cartesian equations	3.3.3 introduce Cartesian coordinates for three-dimensional space, including plotting points and equations of spheres 3.3.4 use vector equations of curves in two or three dimensions involving a parameter and determine a 'corresponding' Cartesian equation in the two-dimensional case 3.3.5 determine a vector equation of a straight line and straight-line segment, given the position of two points or equivalent information, in both two and three dimensions 3.3.6 examine the position of two particles, each described as a vector function of time, and determine if their paths cross or if the particles meet 3.3.7 use the cross product to determine a vector normal to a given plane 3.3.8 determine vector and Cartesian equations of a plane	
2	4	**Vectors** System of linear equations	3.3.9 recognise the general form of a system of linear equations in several variables, and use elementary techniques of elimination to solve a system of linear equations 3.3.10 examine the three cases for solutions of systems of equations – a unique solution, no solution, and infinitely many solutions – and the geometric interpretation of a solution of a system of equations with three variables	
2	5	**Vectors** Vector calculus	3.3.11 consider position vectors as a function of time 3.3.12 derive the Cartesian equation of a path given as a vector equation in two dimensions, including ellipses and hyperbolas 3.3.13 differentiate and integrate a vector function with respect to time 3.3.14 determine equations of motion of a particle travelling in a straight line with both constant and variable acceleration 3.3.15 apply vector calculus to motion in a plane, including projectile and circular motion	Test 2 Week 5

2	6-7	**SEMESTER ONE EXAMS**		
2	8	**Rates of change and differential equations** Application of differentiation	4.2.1 use implicit differentiation to determine the gradient of curves whose equations are given in implicit form 4.2.2 examine related rates as instances of the chain rule: $\frac{dy}{dx}=\frac{dy}{du}\times\frac{du}{dx}$ 4.2.3 apply the incremental formula $\partial y \approx \frac{dy}{dx}\partial x$ to differential equations	
2	9	**Integration and applications of integration** Integration techniques	4.1.2 use substitution u = g(x) to integrate expressions of the form $f\left(g\left(x\right)\right)g'\left(x\right)$	
2	10	**Integration and applications of integration** Integration techniques	4.1.1 integrate using the trigonometric identities $\sin^2 x=\frac{1}{2}\left(1-\cos 2x\right)$, $\cos^2 x=\frac{1}{2}\left(1+\cos 2x\right)$ and $1+\tan^2 x=\sec^2 x$	
2	11	**Integration and applications of integration** Integration techniques	4.1.3 establish and use the formula $\int\frac{1}{x}dx=\ln\lvert x\rvert+c$ for $x\neq 0$ 4.1.4 use partial fractions where necessary for integration in simple cases	
3	1-2	**Integration and applications of integration** Applications of integral calculus	4.1.5 calculate areas between curves determined by functions 4.1.6 determine volumes of solids of revolution about either axis 4.1.7 use technology with numerical integration	Test 3 Week 2

3	3-4	**Rates of change and differential equations** Application of differentiation	4.2.4 solve simple first order differential equations of the form $\frac{dy}{dx}=f(x)$; differential equations of the form $\frac{dy}{dx}=g(y)$; and, in general, differential equations of the form $\frac{dy}{dx}=f(x)g(y)$, using separation of variables 4.2.5 examine slope (direction or gradient) fields of a first order differential equation 4.2.6 formulate differential equations, including the logistic equation that will arise in, for example, chemistry, biology and economics, in situations where rates are involved	Investigation 2 Start Week 3, due start of Week 5
3	5	**Rates of change and differential equations** Modelling motion	4.2.7 consider and solve problems involving motion in a straight line with both constant and non-constant acceleration, including simple harmonic motion and the use of expressions, $\frac{dv}{dt}$, $v\frac{dv}{dx}$ and $\frac{d}{dx}\left(\frac{1}{2}v^2\right)$ for acceleration	
3	6-8	**Statistical inference** Sample means	4.3.1 examine the concept of the sample mean $\overline{X}$ as a random variable whose value varies between samples where X is a random variable with mean μ and the standard deviation σ 4.3.2 simulate repeated random sampling, from a variety of distributions and a range of sample sizes, to illustrate properties of the distribution of $\overline{X}$ across samples of a fixed size n , including its mean μ its standard deviation $\frac{\sigma}{\sqrt{n}}$ (where μ and σ are the mean and standard deviation of X), and its approximate normality if n is large	Test 4 Week 7

		Confidence intervals for means	4.3.3 simulate repeated random sampling, from a variety of distributions and a range of sample sizes, to illustrate the approximate standard normality of $\frac{\overline{X}-\mu}{s/\sqrt{n}}$ for large samples $(n \geq 30)$, where *s* is the sample standard deviation 4.3.4 examine the concept of an interval estimate for a parameter associated with a random variable 4.3.5 examine the approximate confidence interval $\left(\overline{X}-\frac{zs}{\sqrt{n}}, \overline{X}+\frac{zs}{\sqrt{n}}\right)$ as an interval estimate for the population mean μ , where *z* is the appropriate quantile for the standard normal distribution 4.3.6 use simulation to illustrate variations in confidence intervals between samples and to show that most but not all confidence intervals contain μ 4.3.7 use $\overline{x}$ and s to estimate μ and σ to obtain approximate intervals covering desired proportions of values of a normal random variable, and compare with an approximate confidence interval for μ	
3	9-10	SEMESTER TWO EXAM		
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