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

Term	Week	Topic and Key Teaching Points	Syllabus Content	Assessments
1	1	**Differentiation rules** (3.1.7, 3.1.8, 3.1.9) $\frac{d}{dx}(ax^n)$, product, quotient and chain rules on polynomial, hyperbolic, $\sqrt{\ }$ and power functions.	3.1.7 examine and use the product and quotient rules 3.1.8 examine the notion of composition of functions and use the chain rule for determining the derivatives of composite functions 3.1.9 apply the product, quotient and chain rule to differentiate functions such as xe^x, $\frac{1}{x^n}$, and $f(ax-b)$	
1	2-3	**The second derivative and applications of differentiation** (3.1.10 – 3.1.16) on algebraic functions only.	3.1.10 use the increments formula: $\delta y \approx \frac{dy}{dx} \times \delta x$ to estimate the change in the dependent variable y resulting from changes in the independent variable x 3.1.11 apply the concept of the second derivative as the rate of change of the first derivative function 3.1.12 identify acceleration as the second derivative of position with respect to time 3.1.13 examine the concepts of concavity and points of inflection and their relationship with the second derivative 3.1.14 apply the second derivative test for determining local maxima and minima 3.1.15 sketch the graph of a function using first and second derivatives to locate stationary points and points of inflection 3.1.16 solve optimisation problems from a wide variety of fields using first and second derivatives	
1	4			Test 1 - Differentiation rules, The second derivative and applications of differentiation

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1	4-5	**Anti-differentiation** (3.2.1 – 3.2.3, 3.2.6 – 3.2.9) Powers of *x*, excludes exponentials and trigonometric functions. Some applications of integration (3.2.21, 3.2.22)	3.2.1 identify anti-differentiation as the reverse of differentiation 3.2.2 use the notation $\int f(x)dx$ for anti-derivatives or indefinite integrals 3.2.3 establish and use the formula $\int x^n dx = \frac{1}{n+1}x^{n+1} + c$ for $n \neq -1$ 3.2.6 identify and use linearity of anti-differentiation 3.2.7 determine indefinite integrals of the form $\int f(ax - b)dx$ 3.2.8 identify families of curves with the same derivative function 3.2.9 determine $f(x)$, given $f'(x)$ and an initial condition $f(a) = b$ 3.2.21 determine displacement given velocity in linear motion problems 3.2.22 determine positions given linear acceleration and initial values of position and velocity.	
1	6	**Definite integrals** Area under a curve, total change from rate of change (3.2.10 – 3.2.14). Further applications of integration (3.2.18 – 3.2.20)	3.2.10 examine the area problem and use sums of the form $\sum_i f(x_i)\ \delta x_i$ to estimate the area under the curve $y = f(x)$ 3.2.11 identify the definite integral $\int_a^b f(x)dx$ as a limit of sums of the form $\sum_i f(x_i)\ \delta x_i$ 3.2.12 interpret the definite integral $\int_a^b f(x)dx$ as area under the curve $y = f(x)$ if $f(x) > 0$ 3.2.13 interpret $\int_a^b f(x)dx$ as a sum of signed areas 3.2.14 apply the additivity and linearity of definite integrals 3.2.18 calculate total change by integrating instantaneous or marginal rate of change 3.2.19 calculate the area under a curve 3.2.20 calculate the area between curves	Investigation 1 - Calculus

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1	7	**Fundamental Theorem of Calculus** (3.2.15 – 3.2.17)	3.2.15 examine the concept of the signed area function $F(x) = \int_a^x f(t)dt$ 3.2.16 apply the theorem: $F'(x) = \frac{d}{dx}\left(\int_a^x f(t)dt\right) = f(x)$, and illustrate its proof geometrically 3.2.17 develop the formula $\int_a^b f'(x)dx = f(b) - f(a)$ and use it to calculate definite integrals	
1	8 - 9	**Exponential functions** (3.1.1 – 3.1.4, 3.1.9, 3.2.4, 3.2.7)	3.1.1 estimate the limit of $\frac{a^h - 1}{h}$ as $h \to 0$, using technology, for various values of $a > 0$ 3.1.2 identify that e is the unique number a for which the above limit is 1 3.1.3 establish and use the formula $\frac{d}{dx}(e^x) = e^x$ 3.1.4 use exponential functions of the form Ae^{kx} and their derivatives to solve practical problems 3.2.4 establish and use the formula $\int e^x dx = e^x + c$ 3.1.9 apply the product, quotient and chain rule to differentiate functions such as xe^x 3.2.7 determine indefinite integrals of the form $\int f(ax - b)dx$	
1	9			Test 2 – Anti-differentiation, Integration and Applications of Integration, Fundamental Theorem of Calculus, Exponential Functions

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2	1 - 2	**Trigonometric Functions** (3.1.5, 3.1.6, 3.1.9, 3.2.5, 3.2.7 - 3.2.9) Limits of $\frac{\sin x}{x}, \frac{1-\cos x}{x}$	3.1.5 establish the formulas $\frac{d}{dx}(\sin x) = \cos x$ and $\frac{d}{dx}(\cos x) = -\sin x$ by graphical treatment, numerical estimations of the limits, and informal proofs based on geometric constructions 3.1.6 use trigonometric functions and their derivatives to solve practical problems 3.2.5 establish and use the formulas $\int \sin x\, dx = -\cos x + c$ and $\int \cos x\, dx = \sin x + c$ 3.1.9 apply the product, quotient and chain rule to differentiate functions such as $\tan x$, $x \sin x$, $e^{-x} \sin x$ 3.2.7 determine indefinite integrals of the form $\int f(ax - b)dx$ 3.2.8 identify families of curves with the same derivative function 3.2.9 determine $f(x)$, given $f'(x)$ and an initial condition $f(a) = b$	
2	2 - 3	**General Discreet Random Variables** (3.3.1 – 3.3.8) discrete variables, probability distributions and functions (uniform and non-uniform) of the variables, mean (expected value) and SD of a DRV, effect of change of origin and scale on mean and SD.	3.3.1 develop the concepts of a discrete random variable and its associated probability function, and their use in modelling data 3.3.2 use relative frequencies obtained from data to obtain point estimates of probabilities associated with a discrete random variable 3.3.3 identify uniform discrete random variables and use them to model random phenomena with equally likely outcomes 3.3.4 examine simple examples of non-uniform discrete random variables 3.3.5 identify the mean or expected value of a discrete random variable as a measurement of centre, and evaluate it in simple cases	

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			3.3.6 identify the variance and standard deviation of a discrete random variable as measures of spread, and evaluate them using technology 3.3.7 examine the effects of linear changes of scale and origin on the mean and the standard deviation 3.3.8 use discrete random variables and associated probabilities to solve practical problems	
2	3 - 4	**Bernoulli Distributions and Binomial Distributions** (3.3.9 – 3.3.16) terminology (Bernoulli trial, BRV, parameter, Bernoulli distribution, Binomial distribution, mean, Variance, SD), graphs	3.3.9 use a Bernoulli random variable as a model for two-outcome situations 3.3.10 identify contexts suitable for modeling by Bernoulli random variables 3.3.11 determine the mean p and variance $p(1-p)$of the Bernoulli distribution with parameter p 3.3.12 use Bernoulli random variables and associated probabilities to model data and solve practical problems 3.3.13 examine the concept of Bernoulli trials and the concept of a binomial random variable as the number of 'successes' in n independent Bernoulli trials, with the same probability of success p in each trial 3.3.14 identify contexts suitable for modeling by binomial random variables 3.3.15 determine and use the probabilities $P(X=x)=\binom{n}{x}p^x(1-p)^{n-x}$ associated with the binomial	

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			distribution with parameters n and p; note the mean np and variance $np(1-p)$ of a binomial distribution 3.3.16 use binomial distributions and associated probabilities to solve practical problems	
2	4			Test 3 - Trigonometric Functions, General Discreet Random Variables, Bernoulli Distributions and Binomial Distributions
2	5	Review		
2	6 – 7	Year 12 Examinations		Exam 1
2	8 - 10	**Logarithmic functions** (4.1.1 – 4.1.8) Log laws, solving equations, applications, the natural log function, graphs and logarithmic scales.	4.1.1 define logarithms as indices: $a^x = b$ is equivalent to $x = \log_a b$ i.e. $a^{\log_a b} = b$ 4.1.2 establish and use the algebraic properties of logarithms 4.1.3 examine the inverse relationship between logarithms and exponentials: $y = a^x$ is equivalent to $x = \log_a y$ 4.1.4 interpret and use logarithmic scales 4.1.5 solve equations involving indices using logarithms 4.1.6 identify the qualitative features of the graph of $y = \log_a x$ $(a > 1)$, including asymptotes, and of its translations $y = \log_a x + b$ and $y = \log_a (x - c)$ 4.1.7 solve simple equations involving logarithmic functions algebraically and graphically	Investigation 2 - Probability

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			4.1.8 identify contexts suitable for modelling by logarithmic functions and use them to solve practical problems	
2	11	**Calculus of natural logarithmic functions** (4.1.9 – 4.1.14)	4.1.9 define the natural logarithm $\ln x = \log_e x$ 4.1.10 examine and use the inverse relationship of the functions $y = e^x$ and $y = \ln x$ 4.1.11 establish and use the formula $\frac{d}{dx}(\ln x) = \frac{1}{x}$ 4.1.12 establish and use the formula $\int \frac{1}{x} dx = \ln x + c$, for $x > 0$ 4.1.13 determine derivatives of the form $\frac{d}{dx}(\ln f(x))$ and integrals of the form $\int \frac{f'(x)}{f(x)} dx$, for $f(x) > 0$ 4.1.14 use logarithmic functions and their derivatives to solve practical problems	
2	11			Test 4 – Logarithmic Functions and Calculus of Logarithmic Functions
3	11(T2) – (T3) 1	**General continuous random variables** (4.2.1 – 4.2.4).	4.2.1 use relative frequencies and histograms obtained from data to estimate probabilities associated with a continuous random variable 4.2.2 examine the concepts of a probability density function, cumulative distribution function, and probabilities associated with a continuous random variable given by integrals; examine simple types of continuous random variables and use them in appropriate contexts	

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			4.2.3 identify the expected value, variance and standard deviation of a continuous random variable and evaluate them using technology 4.2.4 examine the effects of linear changes of scale and origin on the mean and the standard deviation	
3	2-3	**Normal distribution** (4.2.5 – 4.2.7).	4.2.5 identify contexts, such as naturally occurring variation, that are suitable for modelling by normal random variables 4.2.6 identify features of the graph of the probability density function of the normal distribution with mean μ and standard deviation σ and the use of the standard normal distribution 4.2.7 calculate probabilities and quantiles associated with a given normal distribution using technology, and use these to solve practical problems	
3	3-4	**Random sampling** (4.3.1 – 4.3.3).	4.3.1 examine the concept of a random sample 4.3.2 discuss sources of bias in samples, and procedures to ensure randomness 4.3.3 use graphical displays of simulated data to investigate the variability of random samples from various types of distributions, including uniform, normal and Bernoulli	
3	4			Test 5 - General continuous random variables, General continuous random variables, Normal distribution, Random sampling

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3	5-7	**Sample proportions** (4.3.4 – 4.3.6) and **Confidence intervals for proportions** (4.3.7 – 4.3.10).	4.3.4 examine the concept of the sample proportion $\hat{p}$ as a random variable whose value varies between samples, and the formulas for the mean p and standard deviation $\sqrt{\frac{p(1-p)}{n}}$ of the sample proportion $\hat{p}$ 4.3.5 examine the approximate normality of the distribution of $\hat{p}$ for large samples 4.3.6 simulate repeated random sampling, for a variety of values of p and a range of sample sizes, to illustrate the distribution of $\hat{p}$ and the approximate standard normality of $\frac{\hat{p}-p}{\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}}$ where the closeness of the approximation depends on both n and p 4.3.7 examine the concept of an interval estimate for a parameter associated with a random variable 4.3.8 use the approximate confidence interval $\left(\hat{p}-z\sqrt{\left(\frac{\hat{p}(1-\hat{p})}{n}\right)}, \hat{p}+z\sqrt{\left(\frac{\hat{p}(1-\hat{p})}{n}\right)}\right)$ as an interval estimate for p, where z is the appropriate quantile for the standard normal distribution 4.3.9 define the approximate margin of error $E = z\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ and understand the trade-off between margin of error and level of confidence 4.3.10 use simulation to illustrate variations in confidence intervals between samples and to show that most, but not all, confidence intervals contain p	

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3	7			Test 6 - Sample proportions and Confidence intervals for proportions
3	8	Review of Course		
3	9-10	Exams		Exam (T3, W9/10)