**STAGE 1 MATHEMATICS**

**PROGRAM 3 – SEMESTER 3**

This program is for a cohort of students intending to continue to Mathematical Methods at Stage 2. The following program describes the third semester of learning.

**SEMESTER THREE – 17 WEEKS INCLUDING EXAM WEEK AND STUDENT DEVELOPMENT/ACTIVITY WEEK**

* Topic 9 – Vectors in the Plane Subtopics 9.1, 9.2 and 9.3 (4 Weeks)
* Topic 6 – Introduction to Differential Calculus Subtopics 6.1, 6.2, 6.3, 6.4 and 6.5 (6 Weeks)
* Topic 10 – Further Trigonometry Subtopics 10.1 and 10.2 (5 Weeks)

**Topic 9 – Vectors in the Plane Subtopics 9.1, 9.2 and 9.3 (4 weeks)**

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| **Week** | **Subtopic** | **Concepts and Content**Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| BEGINNING OF SEMESTER – STUDENT DEVELOPMENT WEEK – CAREERS, POSITIVE EDUCATION |
| 2-10 | 9.1Vector Operations | Representation of vectors in the plane by directed line segmentsVector operations including:* Addition and subtraction
* Scalar multiples
* Applications of scalar multiples: parallel vectors and ratio of division
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| 3-1 | 9.2Component and Unit Vector form | Vectors in the Cartesian Plane* Ordered pair notation
* Column vector notation
* Combination of vectors
* Unit vectors
* Position vector

Determination of length and direction of a vector from its components |  |
| 3-2 |  |
| 3-3 | 9.3Projections | Projection of one vector onto another* The dot (scalar) product
* The angle between two vectors
* Perpendicular vectors
* Parallel vectors
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| 3-4 |  | **Revision and SAT 1** | **SAT 1**Subtopics9.1, 9.2 and 9.3Calculator permitted |

**Topic 6 – Introduction to Differential Calculus (6 weeks)**

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| **Week** | **Subtopic** | **Concepts and Content**Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| 3-5 | 6.1Rate of Change | Discussion on rate of change as the ratio of the change in one quantity compared to another* Consider average speeds and other quantities
* Using graphical exemplars to demonstrate how it is found that the average rate of change of a function on the interval from to is given by
* Connection between average rate of change and the slope of the chord
 |  |
| 3-6 | 6.2The Concept of a Derivative | How do we approximate the rate of change at a point (instantaneous rate of change)?* Technology will be implemented to demonstrate this concept. Students will use tables and formula to produce graphical representations to explore how, as an interval from to decreases , the approximation approaches the instantaneous rate of change.

Understanding what a limit is* The instantaneous rate of change of a function at a point is the limit of the average rate of change over an interval approaching zero. (The instantaneous rate of change at any particular point on a curve is the slope of the tangent to the curve drawn at the point.)

Understanding what a derivative is* Introduction to the concept that a derivative can be used to calculate the instantaneous rate of change

Introduction of first principles * Finding the derivative function from first principles
* Using first principles to find the derivative at a given point using
* Students use first principles to calculate derivatives of functions (only integer exponent)
 |  |
| 3-7 | 6.3Computations of Derivatives | Introduction of alternative notation for the derivative of a function Introduction of the derivative rule for simple powers * Students use the derivative rule to calculate the derivatives of functions with integer exponents
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| 6.4Properties of Derivatives | Discussion on the features of the derivative* Is it a function? (Definition of a function readdressed from Topic 1 or briefly given if Topic 1 has not been done)

Recognition and use of the linearity of the derivative* Students establish, by working through appropriate examples, rules of differentiation for simple powers:

 If  If  |
| 3-8 | 6.5Applications of Derivatives | Using derivatives of polynomials and other linear combinations of power functions to determine the equation of a tangent to a curve at a pointUnderstanding the following * Review sign diagrams
* Develop the concepts of displacement and velocity (use of position versus time graphs to describe motion where velocity equates to the slope of the tangent at any point on the graph)
* Rates of change - increasing and decreasing - use of sign diagram to determine intervals in which the function is increasing and decreasing
* Maxima and minima - local and global
* Stationary points and end points

Use of the above to find * Velocity from displacement (first derivative of displacement)
* Object is at rest when velocity is zero
* When an object changes direction i.e. when velocity equals zero and there is a change of sign (sign diagram required)

Optimisation* Examine various optimisation problems (only in consideration of simple polynomials and other linear combinations of power functions) in relation to real life situations such as cost minimisation, optimisation of dimensions of 3D objects, and water use.
 | **INVESTIGATION** Modelling With DerivativesCake Tin Optimisation |
| 3-9 |  |
| 3-10 |  | **Revision and SAT 2****Investigation submission** | **SAT 2 Part 1**First principles and derivatives of polynomialsNo calculator **SAT 2 Part 2** 6.4 and 6.5Calculator permitted |

**Topic 10 – Further Trigonometry (5 weeks)** *The content of this topic assumes Topic 3 - Trigonometry has been completed*

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| **Week** | **Subtopic** | **Concepts and Content**Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| 4-1 | 10.1Further Trigonometric Functions  | Consider the general function * Understanding of *A*, *B*, *C* and *D*

Further extend to the general functions  |  |
| 4-2 | Sketching graphs of the sinusoidal general functions without technology from given data with detail on* Axes labels
* Shape
* Interpretation

Solving, both algebraically and using technology, trigonometric equations of the forms: |  |
| 4-3 | 10.2Trigonometric Identities | Consider the sine and cosine functions and their behaviour in the unit circle. Hence develop the following trigonometric relationships:* (this is a review from subtopic 3.3)
* and
* and

  |  |
| 4-4 | Derive and find expressions for *(time permitting)*Consider the reciprocal trigonometric functions: .Sketch graphs and complete simple transformations for each of these. |  |
| 4-5 |  | **Revision and SAT 3** | **SAT 3**Subtopics 10.1 and 10.2Calculator permitted |
| 4-6 |  | **EXAMINATION REVISION / EXAMS** |  |