# Didactic Document
# Theme-Based Trail about Differential, Integral and Matrix Calculus (Higher Education)

**Trail code: 2710506**

| Contents | Year | Key concepts | Objectives | Data to be collected | Objects | MCM - Task Codes |
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| Integral Calculus<br><br>*Requalification of D. Fernando's garden bandstand* | 13 | - Equation of the parabola<br>- Defined integrals | - Define the equations of the parabolas that bound the region for which you want to calculate the area<br>- Use defined integrals to determine the area of the region bounded by three parabolas | - Maximum height of the region bounded by the three parabolas.<br>- Horizontal distance between the vertices of two consecutive parabolas. | Railing | Task 1245767 |
| Optimization Problem<br><br>*Requalification of D. Fernando's garden bandstand- Phase 2* | 13 | - Derivatives<br>-Optimisation problems | - Write the expression of the area of a triangle inscribed in a circle of known radius<br>- Use the concept of derivative to determine the maximum value of a function | - Diameter of circumference | Railing | Task 1245767-SubTask 2337 |
| Integral Calculus<br><br>*Wreath of flowers at the Shrine of Nossa Senhora D'Agonia* | 13 | - Equation of the parabola<br>- Defined integrals<br>- Length of the curve | - Use defined integrals to calculate the length of a parabola arc | - Gate width (moving part)<br>- Gate height (moving part - side with hinges) | Gate | Task 4845783 |

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| Volume calculation with double integrals<br><br>*Volume of "EcoPonto"* | 13 | - Equation of the plane<br>- Double integrals<br>- Cylindrical coordinates | - Define, in cylindrical coordinates, the shape of the "EcoPonto", a cylinder cut-off at the top by an inclined plane.<br>- Determine the volume of the "EcoPonto" using double integrals and cylindrical coordinates | - Measurement of the two highest heights of the "EcoPonto"<br>- Measurement of the diameter of the circle at the base of the cylinder. | "EcoPonto" – garbage bin | Task 3645779 |
| Vector functions<br><br>*Arched doorway of the Chapel of Santa Catarina* | 13 | - Polar coordinates<br>- Vector functions | - Parametise, using polar coordinates, the equation of a semicircle | - Measurement of the maximum door height<br>- Measurement of the door width | Door | Task 0145770 |
| Matrix Calculus<br><br>*Encrypting the inscription on the statue of João Álvares Fagundes* | 13 | - Matrices<br>- Product of matrices | - Define the encryption matrix from the date inscribed on the right side of the statue.<br>- Cipher the message inscribed on the right side of the statue by applying the product of the matrices. | - Phrase and date inscribed on the right side of the statue | Statue, Memorial plate | Task 3545772 |
| Matrix Calculus<br><br>*Descode the message* | 13 | - Matrices<br>- Product of matrices<br>- Inverse of a matrix | - Calculate the inverse of the Hill encryption matrix.<br>- Decode the message by multiplying the inverse of Hill's encryption matrix by the matrix containing the encrypted message. | - Phrase and date inscribed on the right side of the statue | Statue, Memorial plate | Task 3545772<br><br>SubTask 2338 |
| Area calculation with double integrals<br><br>*Gil Eannes Ship* | 13 | - Double integrals<br>- Polar coordinates | - Define, in polar coordinates, the region of the circle where the new plate will be placed.<br>- Calculate the area of the plate using double integrals. | - Diameter of the circle<br>- Maximum height of the plate | Gate | Task 6745777 |

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| *Gate* | | | | | | |
| Differential calculus<br><br>*Fixing the bicycle parking structure* | 13 | - Derivatives<br>- Geometric interpretation of the derivative concept | - Define the equation of the parabola arc of the bicycle parking structure.<br>- Define the equation of the line tangent to the parabola arc at the midpoint between the vertical foot of the structure and the point where the curve (parabola arc) reaches the ground.<br>- Determine at what point the tangent line touches the ground | - Height of the vertical foot of the structure<br>- The (horizontal) measure between the vertical foot of the structure and the point where the curve (parabola arc) touches the ground. | Structure for bicycle parking | Task 7945774 |