

ERG2011A

Tutorial 1

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Outline

- Revisit the calculus
- Introduction of differential equations
- Methods of solving differential equations

Some Basic Calculus

- About calculus

- Advanced Calculus (5th Edition), by Wilfred Kaplan.
- Page 1 of the textbook-Advanced Engineering Mathematics, by kreyszig.

- Definition of derivative and integral

- Derivatives

$$\sin(x)\cos(x), e^{3x}, 3x^2 + 4ay^3 + 3xy^2$$

- Integral

$$\int x^n dx, \int \sin(x) dx, \int \frac{1}{x^2 + a^2} dx$$

What is a differential equation?

- An equation that involves derivative, and we can solve some unknown function $y(x)$ from the equation.
 - Order: The highest derivatives in the equation.
 - Degree: Power of the highest derivatives term.
 - Linear: All coefficients are functions of independent variables.

- Examples

$$y' = \cos(x)$$

$$y'' + p(x)y' + q(x)y = r(x)$$

$$y' - y^2 = f(x)$$

Method of solving differential equations

- Graphical method
 - Geometric way to plot.
- Separable method: If dy/dx can be expressed in form of separate function of x and y , i.e $dy/dx = g(x)*h(y)$, then this equation can be easily solved by integration.
 - For example, solve $y' = (x+3)(y+1)$.

Method of solving differential equations

■ Reduction to separable form

- Motivation: Some differential equations are not separable but can be made by introducing a new unknown function.
- Sug. 1: Differential equations with the form $y' = g(y/x)$.
- Sug. 2: Try transformation with the form: $v = ay + bx + k$.

■ Examples

- Solve the equation $2xyy' = (y - x)(y+x)$
- Solve the equation $(2x - 4y + 5)y' + x - 2y + 3 = 0$
- Solve the equation $y' = x + y$.
- Solve the equation $y' = x^2 + y^2$.

Thank you😊