# Formation of Differential Equation

**SUBJECT : Mathematics**
**CHAPTER NUMBER: 09**
**CHAPTER NAME : Differential Equations**



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# Formation of the Differential Equation whose General solution is given

Formulating a differential equation from a given equation representing a family of curves means finding a differential equation whose solution is the given equation.

If an equation, representing a family of curves, contains $n$ arbitrary constants, then we differentiate the given equation $n$ times to obtain $n$ more equations. Using all these equations, we eliminate the constants. The equation so obtained is the differential equation of order $n$ for the family of given curves.

# Formation of the Differential Equation whose General solution is given

**Working Rule:**

To formulate a differential equation from a given relation containing the independent variable$(x)$, dependent variable$(y)$, and some arbitrary constants, we may follow the following working rule:

**STEP I:** Write the given equation involving independent variable $x$ (say), dependent variable $y$ (say) and arbitrary constants.

**STEP-II**: Obtain the number of arbitrary constants in Step I. Let there be $n$ arbitrary constants.

**STEP III:** Differentiate the relation in Step I , $n$ times w.r.t. $x$.

**STEP IV:** Eliminate arbitrary constants with the help of $n$ equations involving differential coefficients obtained in Step III and an equation in Step I. The equation so obtained is the desired differential equation.

# Example

Form the differential equation representing the family of curves $y = mx$, where $m$ is an arbitrary constant.

**Remember:**

The number of arbitrary constants present in the equation is equal to the order of the resulting differential equation.

# Example

Form the differential equation representing the family of curves $y = c_1 \cos x + c_2 \sin x$, where $c_1$ and $c_2$ are arbitrary constants.

# Example

Form the differential equation representing the family of curves $x^2 - y^2 = a^2$, where $a$ is an arbitrary constant.

# Example

Form the differential equation of the family of parabolas having vertex at origin and axis along positive $y$-axis.

# Example

Form the differential equation representing the family of curves $y = A\cos(x + B)$, where $A$ and $B$ are arbitrary constants.

# Example

Form the differential equation representing the family of curves given by $y = Ae^{2x} + Be^{5x}$, where A and $B$ are arbitrary constants.

# Assignment

1. Form the differential equation representing the family of circles touching the $y$-axis at origin and centre lies on the $x$-axis.

2. Form the differential equation of the family of ellipses having foci on y-axis and centre at origin.

3. Find the differential equation representing the family of curves $y = ae^{bx+5}$, where $a$ and $b$ are arbitrary constants.

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