**CBSE Class–12 Mathematics**

**NCERT solution**

**Chapter - 9**

**Differential Equations - Exercise 9.1**

**Determine order and degree (if defined) of differential equations given in Questions 1 to 10:**

**1.** $\frac{d^4y}{dx^4}+\sin\left(y'''\right)=0$

**Ans.** Given: $\frac{d^4y}{dx^4}+\sin\left(y'''\right)=0$

The highest order derivative present in the differential equation is $\frac{d^4y}{dx^4}$ and its order is 4.

The given differential equation is not a polynomial equation in derivatives as the term $\sin\left(y'''\right)$ is a T-function of derivative $y'''$. Therefore the degree is not defined.

Hence, order is 4 and degree is not defined.

**2.** $y'+5y=0$

**Ans.** Given: $y'+5y=0$

The highest order derivative present in the differential equation is $y'=\frac{dy}{dx}$ and its order is 1.

The given differential equation is a polynomial equation in derivative $y'$ and the highest power raised to highest order derivative $y'$ is one, so its degree is 1.

Hence, order is 1 and degree is 1.

**3.** $\left(\frac{ds}{dt}\right)^4 + 3s\frac{d^2s}{dt^2} = 0$

**Ans.** Given: $\left(\frac{ds}{dt}\right)^4 + 3s\frac{d^2s}{dt^2} = 0$

The highest order derivative present in the differential equation is $\frac{d^2s}{dt^2}$ and its order is 2.

The given differential equation is a polynomial equation in derivatives and the highest power raised to highest order derivative $\frac{d^2s}{dt^2}$ is one, so its degree is 1.

Hence, order is 2 and degree is 1.

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**4.** $\left(\frac{d^2y}{dx^2}\right)^2 + \cos\frac{dy}{dx} = 0$

**Ans.** Given: $\left(\frac{d^2y}{dx^2}\right)^2 + \cos\frac{dy}{dx} = 0$

The highest order derivative present in the differential equation is $\frac{d^2y}{dx^2}$ and its order is 2.

The given differential equation is not a polynomial equation in derivatives as the term $\cos\frac{dy}{dx}$ is a T-function of derivative $\frac{dy}{dx}$. Therefore the degree is not defined.

Hence, order is 2 and degree is not defined.

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**5.** $\frac{d^2y}{dx^2} = \cos 3x + \sin 3x$

**Ans.** Given: $\frac{d^2y}{dx^2} = \cos 3x + \sin 3x$

The highest order derivative present in the differential equation is $\frac{d^2y}{dx^2}$ and its order is 2.

The given differential equation is a polynomial equation in derivatives and the highest power raised to highest order $\frac{d^2y}{dx^2} = \left(\frac{d^2y}{dx^2}\right)^1$ is one, so its degree is 1.

Hence, order is 2 and degree is 1.

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**6.** $(y''')^2 + (y'')^3 + (y')^4 + y^5 = 0$

**Ans.** Given: $(y''')^2 + (y'')^3 + (y')^4 + y^5 = 0$

The highest order derivative present in the differential equation is $y'''$ and its order is 3.

The given differential equation is a polynomial equation in derivatives and the highest power raised to highest order $y'''$ is two, so its degree is 2.

Hence, order is 3 and degree is 2.

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**7.** $y''' + 2y'' + y' = 0$

**Ans.** Given: $y''' + 2y'' + y' = 0$

The highest order derivative present in the differential equation is $y'''$ and its order is 3.

The given differential equation is a polynomial equation in derivatives $y'''$, $y''$ and $y'$ and the highest power raised to highest order $y'''$ is two, so its degree is 1.

Hence, order is 3 and degree is 1.

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**8.** $y' + y = e^x$

**Ans.** Given: $y' + y = e^x$

The highest order derivative present in the differential equation is $y'$ and its order is 1.

The given differential equation is a polynomial equation in derivative $y'$. It may be noted that $e^x$ is an exponential function and not a polynomial function but is not an exponential function of derivatives and the highest power raised to highest order derivative $y'$ is one so its degree is one.

Hence, order is 1 and degree is 1.

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**9.** $y''+(y')^2+2y=0$

**Ans.** Given: $y''+(y')^2+2y=0$

The highest order derivative present in the differential equation is $y''$ and its order is 2.

The given differential equation is a polynomial equation in derivatives $y''$ and $y'$ and the highest power raised to highest order $y''$ is one, so its degree is 1.

Hence, order is 2 and degree is 1.

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**10.** $y''+2y'+\sin y=0$

**Ans.** Given: $y''+2y'+\sin y=0$

The highest order derivative present in the differential equation is $y''$ and its order is 2.

The given differential equation is a polynomial equation in derivative $y''$ and $y'$. It may be noted that $\sin y$ is not a polynomial function of $y$, it is a T-function of $y$ but is not a T-function of derivatives and the highest power raised to highest order derivative $y''$ is one so its degree is one.

Hence, order is 2 and degree is 1.

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**11. The degree of the differential equation** $\left(\frac{d^2y}{dx^2}\right)^3+\left(\frac{dy}{dx}\right)^2+\sin\left(\frac{dy}{dx}\right)+1=0$ **is:**

**(A) 3**

**(B) 2**

**(C) 1**

**(D) Not defined**

**Ans.** Given: $\left(\frac{d^2y}{dx^2}\right)^3+\left(\frac{dy}{dx}\right)^2+\sin\left(\frac{dy}{dx}\right)+1=0$ .....(i)

This equation is not a polynomial in derivatives as $\sin\left(\frac{dy}{dx}\right)$ is a T-function of derivative $\frac{dy}{dx}$.

Therefore, degree of given equation is not defined.

Hence, option (D) is correct.

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**12. The order of the differential equation $2x^2\frac{d^2y}{dx^2}-3\frac{dy}{dx}+y=0$ is:**

**(A) 2**

**(B) 1**

**(C) 0**

**(D) Not defined**

**Ans.** Given: $2x^2\frac{d^2y}{dx^2}-3\frac{dy}{dx}+y=0$

The highest order derivative present in the differential equation is $\frac{d^2y}{dx^2}$ and its order is 2.

Therefore, option (A) is correct.