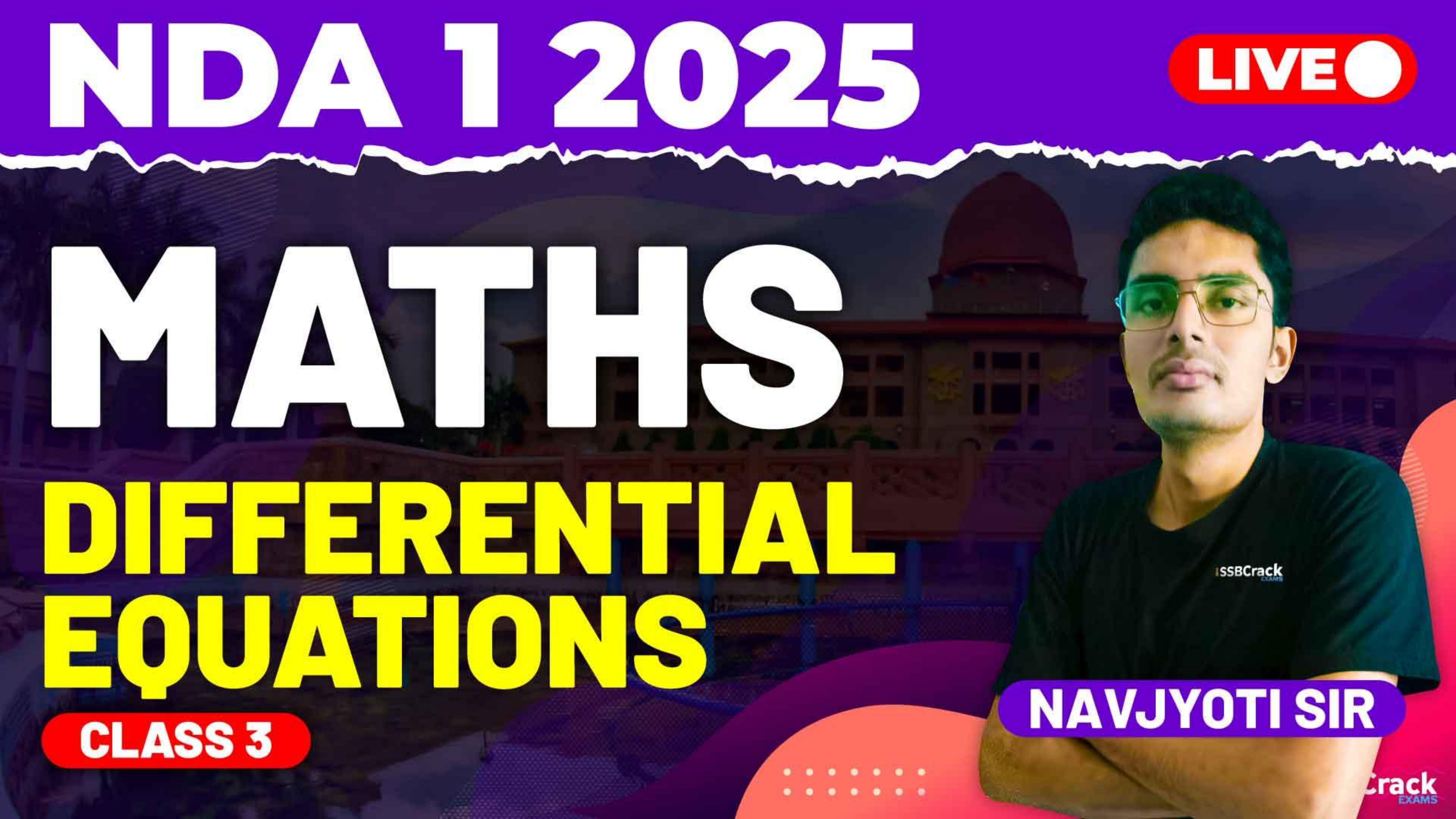
NDA 1 2025
LIVE
MATHS
DIFFERENTIAL EQUATIONS
CLASS 3
NAVJYOTI SIR
SSBCrack EXAMS

Let $y\,dx + (x - y^3)\,dy = 0$ be a differential equation.

What are the order and degree respectively of the differential equation?

(a) 1 and 1

(b) 1 and 2

(c) 2 and 1

(d) 1 and 3

$$\frac{dy}{dx} = \frac{y}{y^3 - x}$$

Order = 1

degree = 1

Let $y\,dx + (x - y^3)\,dy = 0$ be a differential equation.

What are the order and degree respectively of the differential equation?

(a) 1 and 1

(b) 1 and 2

(c) 2 and 1

(d) 1 and 3

Ans: (a)

Let $y\,dx + (x - y^3)\,dy = 0$ be a differential equation.

What is the solution of the differential equation?

(a) $y^4 + 2x = c$

(b) $y^4 + 3x = c$

(c) $2xy^4 + x = c$

(d) $4xy - y^4 = c$

$$\frac{dy}{dx} = \frac{y}{y^3 - x}$$

$$\frac{dx}{dy} = \frac{y^3 - x}{y}$$

(Linear diff. eqn.)

$$\frac{dx}{dy} + \left(\frac{1}{y}\right)x = y^2$$

$$\frac{dx}{dy} + Px = Q$$

$P, Q \rightarrow f(y)$ or constants

$$\frac{dx}{dy} + \left(\frac{1}{y}\right)x = y^2$$

$P = \frac{1}{y}$; $Q = y^2$

$$IF = e^{\int P\,dy} = e^{\int \frac{1}{y}dy} = e^{\log y} = \underline{y}$$

Soln.

$$x(IF) = \int Q(IF)\,dy + C$$

$$xy = \int y^2(y)\,dy + C \Rightarrow xy = \frac{y^4}{4} + C$$

$$4xy = y^4 + 4C$$

$$4xy - y^4 = C$$

Let $y\,dx + (x - y^3)\,dy = 0$ be a differential equation.

What is the solution of the differential equation?

(a) $y^4 + 2x = c$

(b) $y^4 + 3x = c$

(c) $2xy^4 + x = c$

(d) $4xy - y^4 = c$

Ans: (d)

Let $y_1(x)$ and $y_2(x)$ be two solutions of the differential equation $\frac{dy}{dx} = x$. If $y_1(0) = 0$ and $y_2(0) = 4$, then what is the number of points of intersection of the curves $y_1(x)$ and $y_2(x)$?

(a) No point

(b) One point

(c) Two points

(d) More than two points

$$\frac{dy}{dx} = x$$

$$\int dy = \int x\,dx \quad \text{(variable - Seperable)}$$

$$y = \frac{x^2}{2} + C$$

$$y_1(x) = \frac{x^2}{2} + C_1$$

$$y_1(0) = \frac{0^2}{2} + C_1$$

$$0 = C_1 \Rightarrow C_1 = 0$$

$$y_2(x) = \frac{x^2}{2} + C_2$$

$$y_2(0) = \frac{0^2}{2} + C_2$$

$$4 = C_2$$

$$y_1(x) = \frac{x^2}{2} + c_1$$

$$y_2(x) = \frac{x^2}{2} + c_2$$

$$y_1(x) = \frac{x^2}{2}$$

$$y_2(x) = \frac{x^2}{2} + 4$$

$y_1(x) = y_2(x)$ (for points of intersection)

$$\frac{x^2}{2} = \frac{x^2}{2} + 4$$

↳ (no value of x is possible)

Let $y_1(x)$ and $y_2(x)$ be two solutions of the differential equation $\frac{dy}{dx} = x$. If $y_1(0) = 0$ and $y_2(0) = 4$, then what is the number of points of intersection of the curves $y_1(x)$ and $y_2(x)$?

(a) No point

(b) One point

(c) Two points

(d) More than two points

Ans: (a)

The differential equation, representing the curve $y = e^x(a \cos x + b \sin x)$ where a and b are arbitrary constants, is

(a) $\frac{d^2y}{dx^2} + 2y = 0$

(b) $\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 2y = 0$

(c) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0$

(d) $\frac{d^2y}{dx^2} + y = 0$

$y = e^x(a\cos x + b\sin x)$

$y' = e^x(-a\sin x + b\cos x) + (a\cos x + b\sin x)e^x$

$y' = e^x(-a\sin x + b\cos x) + y$ —— (1)

$y'' = e^x(-a\cos x - b\sin x) + (-a\sin x + b\cos x)e^x + y'$

$y'' - y' = -e^x(a\cos x + b\sin x) + \underline{(-a\sin x + b\cos x)e^x}$

from (1)

$y'' - y' = -y + \underline{y' - y}$

$$y'' - y' = -y + y' - y$$

$$y'' - 2y' + 2y = 0$$

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0$$

The differential equation, representing the curve $y = e^x(a \cos x + b \sin x)$ where a and b are arbitrary constants, is

(a) $\frac{d^2y}{dx^2} + 2y = 0$

(b) $\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 2y = 0$

(c) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0$

(d) $\frac{d^2y}{dx^2} + y = 0$

Ans: (c)

Q) The solution of $\frac{dy}{dx} = |x|$ is :

(a) $y = \frac{x|x|}{2} + c$

(b) $y = \frac{|x|}{2} + c$

(c) $y = \frac{x^2}{2} + c$

(d) $y = \frac{x^3}{2} + c$

Where c is an arbitary constant

$\frac{dy}{dx} = x$ if $x \geq 0$ and $\frac{dy}{dx} = -x$ if $x < 0$

$y = \frac{x^2}{2} + c$

$y = -\frac{x^2}{2} + c$

combining both results, $\frac{x|x|}{2} + c$

Q) The solution of $\frac{dy}{dx} = |x|$ is :

(a) $y = \frac{x|x|}{2} + c$

(b) $y = \frac{|x|}{2} + c$

(c) $y = \frac{x^2}{2} + c$

(d) $y = \frac{x^3}{2} + c$

Where c is an arbitary constant

Ans: (a)

Q) The differential equation of the curve $y = \sin x$ is

(a) $\frac{d^2y}{dx^2} + y\frac{dy}{dx} + x = 0$ (b) $\frac{d^2y}{dx^2} + y = 0$

(c) $\frac{d^2y}{dx^2} - y = 0$ (d) $\frac{d^2y}{dx^2} + x = 0$

$y' = \cos x$

$y'' = -\sin x = -y$

$y'' = -y \Rightarrow y'' + y = 0$

$\frac{d^2y}{dx^2} + y = 0$

Q) The differential equation of the curve $y = \sin x$ is

(a) $\frac{d^2y}{dx^2} + y\frac{dy}{dx} + x = 0$

(b) $\frac{d^2y}{dx^2} + y = 0$

(c) $\frac{d^2y}{dx^2} - y = 0$

(d) $\frac{d^2y}{dx^2} + x = 0$

Ans: (b)

Q) The general solution of the differential equation

$\ell n\left(\frac{dy}{dx}\right)+x=0$ is?

(a) $y=e^{-x}+c$ (b) $y=-e^{-x}+c$ ✓

(c) $y=e^{x}+c$ (d) $y=-e^{x}+c$

$$\ln\left(\frac{dy}{dx}\right) = -x$$

$$\frac{dy}{dx} = e^{-x} \Rightarrow \int dy = \int e^{-x}\,dx \Rightarrow y = \frac{e^{-x}}{(-1)} + c$$

$$y = -e^{-x} + c$$

Q) The general solution of the differential equation

$\ell n\left(\frac{dy}{dx}\right)+x=0$ is?

(a) $y=e^{-x}+c$

(b) $y=-e^{-x}+c$

(c) $y=e^{x}+c$

(d) $y=-e^{x}+c$

Ans: (b)

Q) What is the degree of the differential equation

$$\left(\frac{d^4y}{dx^4}\right)^{3/5} - 5\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} - 8\frac{dy}{dx} + 5 = 0 \ ?$$

(a) 5 (b) 4

(c) 3 (d) 2

$$\left(\frac{d^4y}{dx^4}\right)^{3/5} = 5\frac{d^3y}{dx^3} - 6\frac{d^2y}{dx^2} + 8\frac{dy}{dx} - 5$$

$$\left(\frac{d^4y}{dx^4}\right)^{3} = \left(5\frac{d^3y}{dx^3} - 6\frac{d^2y}{dx^2} + 8\frac{dy}{dx} - 5\right)^5$$

degree = 3

Q) What is the degree of the differential equation

$$\left(\frac{d^4y}{dx^4}\right)^{3/5} - 5\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} - 8\frac{dy}{dx} + 5 = 0 \ ?$$

(a) 5 (b) 4

(c) 3 (d) 2

Ans: (c)

Q) The differential equation representing the family of curves $y = a \sin(\lambda x + \alpha)$ is :

(a) $\frac{d^2y}{dx^2} + \lambda^2 y = 0$ (b) $\frac{d^2y}{dx^2} - \lambda^2 y = 0$

(c) $\frac{d^2y}{dx^2} + \lambda y = 0$ (d) None of the above

$y' = a\cos(\lambda x + \alpha)\lambda$

$y' = a\lambda\cos(\lambda x + \alpha)$

$y'' = a\lambda^2(-\sin(\lambda x + \alpha)) \longrightarrow y'' = -a\lambda^2\left(\frac{y}{a}\right) \Rightarrow y'' = -\lambda^2 y$

$y'' + \lambda^2 y = 0$

Q) The differential equation representing the family of curves $y = a \sin(\lambda x + \alpha)$ is :

(a) $\frac{d^2y}{dx^2} + \lambda^2 y = 0$

(b) $\frac{d^2y}{dx^2} - \lambda^2 y = 0$

(c) $\frac{d^2y}{dx^2} + \lambda y = 0$

(d) None of the above

Ans: (a)

Q) The solution of the differential equation

$$\frac{dy}{dx} = \cos(y - x) + 1 \text{ is}$$

(a) $e^x[\sec(y-x) - \tan(y-x)] = c$ ✗

(b) $e^x[\sec(y-x) + \tan(y-x)] = c$

(c) $e^x \sec(y-x)\tan(y-x) = c$ ✗

(d) $e^x = c\sec(y-x)\tan(y-x)$ ✗

$y - x = t$

$\frac{dy}{dx} - 1 = \frac{dt}{dx} \Rightarrow \frac{dy}{dx} = 1 + \frac{dt}{dx}$

$1 + \frac{dt}{dx} = \cos t + 1$

$\int \frac{1}{\cos t} dt = \int dx$

$\log(\sec t + \tan t)) = x + c$

$$\log(\sec t + \tan t)) = x + C$$

$$\log(\sec t + \tan t) - \log C = x$$

$$\log\left(\frac{\sec t + \tan t}{c}\right) = x$$

$$\sec(y-x) + \tan(y-x) = Ce^{x}$$

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Q) The solution of the differential equation

$$\frac{dy}{dx} = \cos(y - x) + 1 \text{ is}$$

(a) $e^x[\sec(y - x) - \tan(y - x)] = c$

(b) $e^x[\sec(y - x) + \tan(y - x)] = c$

(c) $e^x \sec(y - x) \tan(y - x) = c$

(d) $e^x = c \sec(y - x) \tan(y - x)$

Ans: (a)

Q) If $y = a\cos 2x + b\sin 2x$, then

(a) $\frac{d^2y}{dx^2} + y = 0$ (b) $\frac{d^2y}{dx^2} + 2y = 0$

(c) $\frac{d^2y}{dx^2} - 4y = 0$ (d) $\frac{d^2y}{dx^2} + 4y = 0$

Q) If $y = a\cos 2x + b\sin 2x$, then

(a) $\frac{d^2y}{dx^2} + y = 0$ (b) $\frac{d^2y}{dx^2} + 2y = 0$

(c) $\frac{d^2y}{dx^2} - 4y = 0$ (d) $\frac{d^2y}{dx^2} + 4y = 0$

Ans: (d)

Q) The differential equation of the system of circles touching the Y-axis at the origin is

(a) $x^2 + y^2 - 2xy \frac{dy}{dx} = 0$

(b) $x^2 + y^2 + 2xy \frac{dy}{dx} = 0$

(c) $x^2 - y^2 + 2xy \frac{dy}{dx} = 0$

(d) $x^2 - y^2 - 2xy \frac{dy}{dx} = 0$

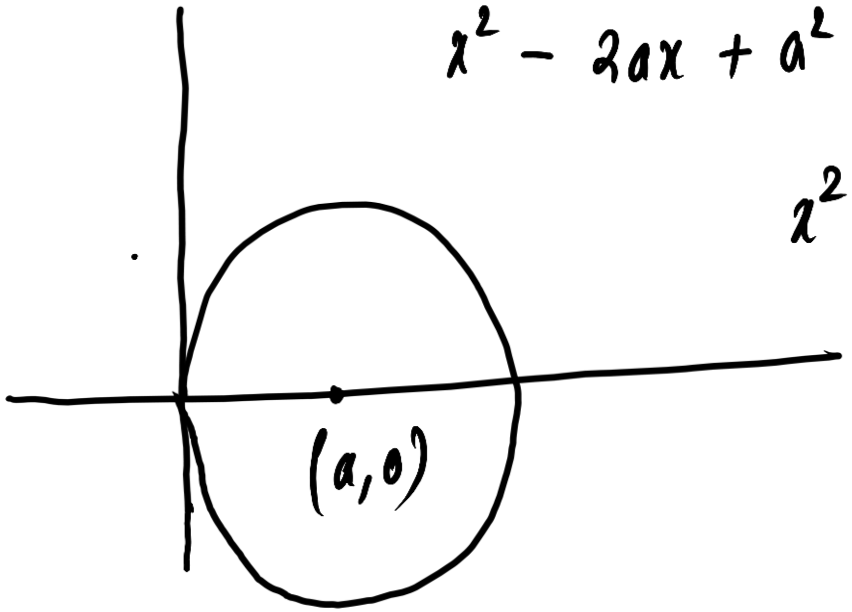
radius = a; centre → (a, 0)

$(x-a)^2 + (y-0)^2 = a^2$

$x^2 - 2ax + a^2 + y^2 = a^2$

$x^2 - 2ax + y^2 = 0$

$y^2 = 2ax - x^2$



$$y^2 = 2ax - x^2 \longrightarrow a = \frac{y^2 + x^2}{2x}$$

$$2yy' = 2a - 2x$$

$$yy' = a - x$$

$$yy' = \frac{y^2 + x^2}{2x} - x$$

$$yy' = \frac{y^2 + x^2 - 2x^2}{2x}$$

$$2xy\frac{dy}{dx} = y^2 - x^2$$

$$x^2 - y^2 + 2xy\frac{dy}{dx} = 0$$

Q) The differential equation of the system of circles touching the Y-axis at the origin is

(a) $x^2 + y^2 - 2xy \dfrac{dy}{dx} = 0$

(b) $x^2 + y^2 + 2xy \dfrac{dy}{dx} = 0$

(c) $x^2 - y^2 + 2xy \dfrac{dy}{dx} = 0$

(d) $x^2 - y^2 - 2xy \dfrac{dy}{dx} = 0$

Ans: (c)

Q) Consider the following statements:

1. The general solution of $\frac{dy}{dx} = f(x) + x$ is of the form $y = g(x) + c$, where c is an arbitrary constant. ✓

2. The degree of $\left(\frac{dy}{dx}\right)^2 = f(x)$ is 2. ✓

Which of the above statements is/are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

$$y = \int f(x)\,dx + \int x\,dx$$

$$y = F(x) + \frac{x^2}{2} + c$$

$$y = g(x) + c$$

Q) Consider the following statements:

1. The general solution of $\frac{dy}{dx} = f(x) + x$ is of the form $y = g(x) + c$, where c is an arbitrary constant.

2. The degree of $\left(\frac{dy}{dx}\right)^2 = f(x)$ is 2.

Which of the above statements is/are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Ans: (c)

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Q) Which one of the following differential equations is not linear?

Linear → degree = 1

(a) $\frac{d^2y}{dx^2} + 4y = 0$

(b) $x\frac{dy}{dx} + y = x^3$ ✓

(c) $(x-y)^2\frac{dy}{dx} = 9$ ✓

(d) $\cos^2 x\frac{dy}{dx} + y = \tan x$

$$\frac{dy}{dx} + Py = Q$$

$$\frac{dy}{dx} = \frac{9}{x^2+y^2-2xy}$$

$$\frac{dx}{dy} = \frac{x^2+y^2-2xy}{9}$$

$\frac{dx}{dy} + Px = Q$ (cannot be expressed)

Q) Which one of the following differential equations is not linear?

(a) $\frac{d^2y}{dx^2} + 4y = 0$

(b) $x\frac{dy}{dx} + y = x^3$

(c) $(x - y)^2 \frac{dy}{dx} = 9$

(d) $\cos^2 x \frac{dy}{dx} + y = \tan x$

Ans: (c)

Q) Consider a differential equation of order m and degree n. Which one of the following pairs is not feasible ?

(a) (3, 2)

(b) (2, 3/2)

(c) (2, 4)

(d) (2, 2)

degree $= \frac{3}{2}$ is not possible.

Q) Consider a differential equation of order m and degree n. Which one of the following pairs is not feasible ?

(a) $(3, 2)$ (b) $(2, 3/2)$

(c) $(2, 4)$ (d) $(2, 2)$

Ans: (b)

Q) Which one of the following is the differential equation to family of circles having centre at the origin?

(a) $\left(x^2 - y^2\right)\frac{dy}{dx} = 2xy$ (b) $\left(x^2 + y^2\right)\frac{dy}{dx} = 2xy$

(c) $\frac{dy}{dx} = \left(x^2 + y^2\right)$ (d) $xdx + ydy = 0$

$x^2 + y^2 = a^2$

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(c) $\frac{dy}{dx} = \left(x^2 + y^2\right)$ (d) $xdx + ydy = 0$

Ans: (d)

Q) The growth of a quantity $N(t)$ at any instant t is given by $\frac{dN(t)}{dt} = \alpha N(t)$. Given that $N(t) = ce^{kt}$, c is a constant. What is the value of α?

(a) c

(b) k

(c) $c + k$

(d) $c - k$

Q) The growth of a quantity $N(t)$ at any instant t is given by $\frac{dN(t)}{dt} = \alpha N(t)$. Given that $N(t) = ce^{kt}$, c is a constant. What is the value of α?

(a) c

(b) k

(c) $c + k$

(d) $c - k$

Ans: (b)

Q) The degree and order of the differential equation of the family of all parabolas whose axis is x - axis, are respectively.

(a) 2, 3 (b) 2, 1 (c) 1, 2 (d) 3, 2.

Q) The degree and order of the differential equation of the family of all parabolas whose axis is x - axis, are respectively.

(a) 2, 3 (b) 2, 1 (c) 1, 2 (d) 3, 2.

Ans: (c)

Q) The solution of the differential equation

$$(1+y^2)+(x-e^{\tan^{-1}y})\frac{dy}{dx}=0 \text{ , is}$$

(a) $xe^{2\tan^{-1}y}=e^{\tan^{-1}y}+k$ (b) $(x-2)=ke^{2\tan^{-1}y}$

(c) $2xe^{\tan^{-1}y}=e^{2\tan^{-1}y}+k$ (d) $xe^{\tan^{-1}y}=\tan^{-1}y+k$

$$\frac{dy}{dx} = -\frac{1+y^2}{x-e^{\tan^{-1}y}} = \frac{1+y^2}{e^{\tan^{-1}y}-x}$$

$$\frac{dx}{dy}+\frac{x}{1+y^2}=\frac{e^{\tan^{-1}y}}{1+y^2} \quad \left(\frac{dx}{dy}+Px=Q\right)$$

Q) The solution of the differential equation

$$(1+y^2)+(x-e^{\tan^{-1}y})\frac{dy}{dx}=0\text{ , is}$$

(a) $xe^{2\tan^{-1}y}=e^{\tan^{-1}y}+k$ (b) $(x-2)=ke^{2\tan^{-1}y}$

(c) $2xe^{\tan^{-1}y}=e^{2\tan^{-1}y}+k$ (d) $xe^{\tan^{-1}y}=\tan^{-1}y+k$

Ans: (c)

Q) Solution of the differential equation $ydx + (x + x^2 y)dy = 0$ is

(a) $\log y = Cx$

(b) $-\frac{1}{xy} + \log y = C$

(c) $\frac{1}{xy} + \log y = C$

(d) $-\frac{1}{xy} = C$

Q) Solution of the differential equation $ydx + (x + x^2 y)dy = 0$ is

(a) $\log y = Cx$

(b) $-\frac{1}{xy} + \log y = C$

(c) $\frac{1}{xy} + \log y = C$

(d) $-\frac{1}{xy} = C$

Ans: (b)

Q) If $x\frac{dy}{dx} = y(\log y - \log x + 1)$, then the solution of the equation is

(a) $y\log\left(\frac{x}{y}\right) = cx$

(b) $x\log\left(\frac{y}{x}\right) = cy$

(c) $\log\left(\frac{y}{x}\right) = cx$

(d) $\log\left(\frac{x}{y}\right) = cy$

Q) If $x\dfrac{dy}{dx} = y\,(\log y - \log x + 1)$, then the solution of the equation is

(a) $y \log\left(\dfrac{x}{y}\right) = cx$

(b) $x \log\left(\dfrac{y}{x}\right) = cy$

(c) $\log\left(\dfrac{y}{x}\right) = cx$

(d) $\log\left(\dfrac{x}{y}\right) = cy$

Ans: (b)

Q) Let the population of rabbits surviving at time t be governed by the differential equation $\frac{dp(t)}{dt} = \frac{1}{2}p(t) - 200$. If $p(0) = 100$, then $p(t)$ equals:

(a) $600 - 500\,e^{t/2}$ (b) $400 - 300\,e^{-t/2}$

(c) $400 - 300\,e^{t/2}$ (d) $300 - 200\,e^{-t/2}$

Q) Let the population of rabbits surviving at time t be governed by the differential equation $\frac{dp(t)}{dt} = \frac{1}{2}p(t) - 200$. If $p(0) = 100$, then $p(t)$ equals:

(a) $600 - 500\, e^{t/2}$

(b) $400 - 300\, e^{-t/2}$

(c) $400 - 300\, e^{t/2}$

(d) $300 - 200\, e^{-t/2}$

Ans: (d)

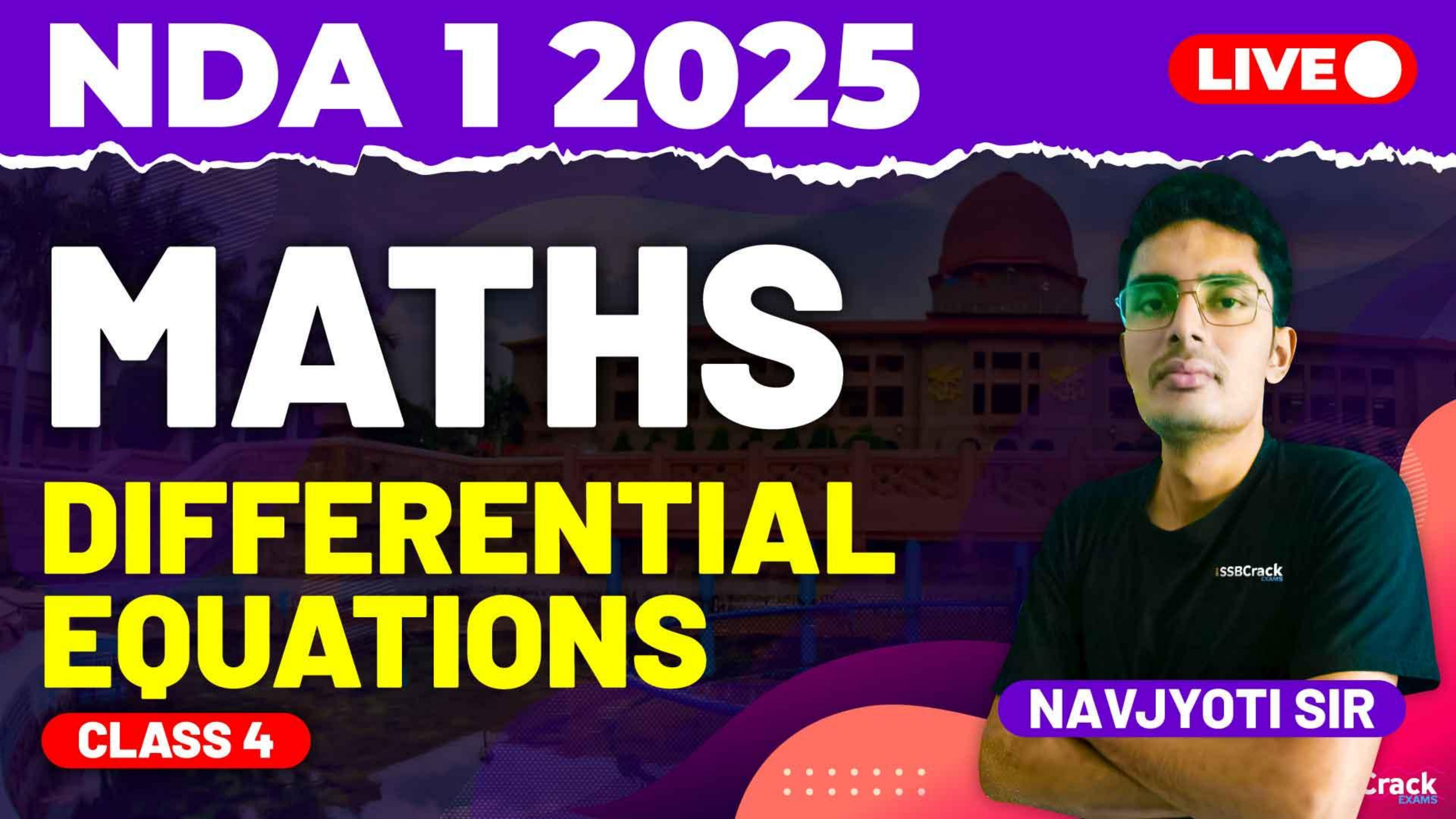
Q) At present, a firm is manufacturing 2000 items. It is estimated that the rate of change of production P w.r.t. additional number of workers x is given by $\frac{dP}{dx} = 100 - 12\sqrt{x}$. If the firm employs 25 more workers, then the new level of production of items is

(a) 2500 (b) 3000 (c) 3500 (d) 4500

Q) At present, a firm is manufacturing 2000 items. It is estimated that the rate of change of production P w.r.t. additional number of workers x is given by $\frac{dP}{dx} = 100 - 12\sqrt{x}$. If the firm employs 25 more workers, then the new level of production of items is

(a) 2500 (b) 3000 (c) 3500 (d) 4500

Ans: (c)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