First Order & First Degree ODE - V

Detailed Course on Differential Equation for IIT JAM' 23 - II

Gajendra Purohit • Lesson 4 • Aug 10, 2022

Gajendra Purohit

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HOMOGENEOUS DIFFERENTIAL EQUATION

Homogeneous Function : A function f(x, y) is called homogeneous function of degree 'n' if $f(\lambda x, \lambda y) = \lambda^n f(x, y)$; for all x, y; $\lambda \geq 0$

Example : $f(x, y) = 2x^3 - 3xy^2 + 4y^3$

Solution : $f(\lambda x + \lambda y) = 2\lambda^3 x^3 - 3\lambda^3 xy^2 + 4\lambda^3 y^3$

$= \lambda^3 f(x, y)$

This function is homogeneous of degree 3.

Note : A differential equation of first order and first degree is said to be homogeneous if it can be put in the form

$$\frac{dy}{dx} = \phi\left(\frac{y}{x}\right) = \phi\left(\frac{x}{y}\right).$$

Note :

1. Every homogeneous first order DE is reducible into seperable variable.

2. A function f(x, y) is homogeneous of degree n then $x\frac{\partial f}{\partial x}+y\frac{\partial f}{\partial y}=nf$.

Working Rule for solving homogeneous equation :

Let $\frac{dy}{dx} = f\left(\frac{y}{x}\right)$ is a homogeneous equation, then

Step – 1 : Put $y/x = v \Rightarrow y = vx$

Step – 2 : $\frac{dy}{dx} = v + x\frac{dv}{dx}$

Step – 3 : Put both value in DE

Step – 4 : Using separation of variable we get required solution.

Q.1. The differential equation $(x^2 + y^2)\frac{dy}{dx} = xy$ s.t. $y(0) = 1$ has

(a) Unique solution (b) Infinite solution

(c) Two solution (d) None of these

Q.2. The general solution of the differential equation $(x^2 - y^2)dx + 2xydy = 0$ is

(a) $x^2 - y^2 = c$

(b) $x^2 + y^2 = c$

(c) $x^2 - y^2 = cx$

(d) None

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Q.3. Consider the following difference equation

$$x(ydx+xdy)\cos\frac{y}{x}=y(xdy-ydx)\sin\frac{y}{x}$$

Which of the following is solution of the above equation?

(a) $\frac{x}{y}\cos\frac{y}{x}=c$

(b) $\frac{x}{y}\sin\frac{y}{x}=c$

(c) $xy\cos\frac{y}{x}=c$

(d) $xy\sin\frac{y}{x}=c$

Equation reducible to homogeneous form

Equation of the form $\frac{dy}{dx}=\frac{ax+by+c}{a`x+b`y+c`}$, where $\frac{a}{a`}\neq\frac{b}{b`}$ can be reduced to homogeneous form.

Working rule :

(1) Take x = X + h & y = Y + k, then $\frac{dy}{dx}=\frac{dY}{dX}$.

(2) Put all values in above DE

$$\frac{dY}{dX}=\frac{aX+bY+ah+bk+c}{a`x+b`y+a`h+b`k+c`}$$

(3) Find value of h & k for which ah + bk + c = 0 & a`h + b`k + c` = 0,

Then $\frac{dY}{dX}=\frac{aX+bY}{a`X+b`Y}$ which homogeneous.

(4) Solve this DE and put X = x – h & Y = y – k

Q.6. Solution of $\frac{dy}{dx} = \frac{(xy^2 - x^2 y)}{x^3}$ s.t. $y(1) = 2$

(a) Unique solution

(b) No solution

(c) Infinite solution

(d) None of these

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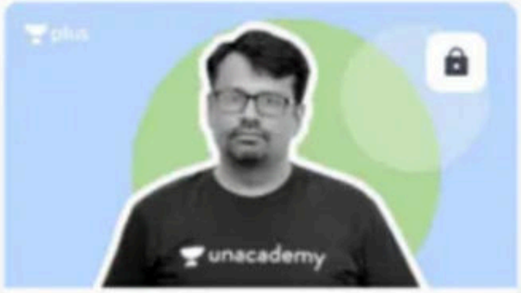

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Educator highlights

- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
- PhD, NET | Plus Educator For CSIR NET | Youtuber (260K+Subs.) | Director Pacific Science College |
- Lives in **Udaipur, Rajasthan, India**
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