

ELIMINATION OF ARBITRARY CONSTANTS AND FAMILY OF CURVES

CHAPTER 1
ELIMINATION OF ARBITRARY CONSTANTS

1. $x^2 - 2x^2y + c$
 $2x^2y - 2x^2y - 2y(2x)dy = 0$
 $2x^2dy - 4xydy - 2x^2ydy = 0$
 divide by $2x$
 $x^2dy - 2xydy - x^2ydy = 0$
 $\therefore (x+2y)dx - xdy = 0$ ans.

2. $y \sin x - xy^2 + c$
 $y(\cos x dx) + (dx dy - dy^2) = 0$
 $y^2 dx = 0$
 $y^2 dx + dy^2 = dx dy - dy^2 + dy^2 = 0$
 $y^2 dx + dy^2 = dx dy$ ans.

3. $x^2y + 1 + c$
 $x^2dy + 2xydx = 0 + 1 dx$
 divide by dx
 $x^2 \frac{dy}{dx} + 2xy = 1$

substitute
 $x^2y = 1 + x^2 \frac{dy}{dx} + 2xy$
 $x^2y = 1 + x^2 \frac{dy}{dx} + 2xy$
 $x^2y dx = dx + x^2 dy + 2xy dx$
 $dx + x^2 dy + 2xy dx = x^2y dx$
 $\therefore (x^2y - 1)dx + x^2 dy = 0$ ans.

4. $cy^2 = x^2 + y$
 $\frac{x^2 + y}{y^2} = c$
 $\frac{x^2(dx + 2x) + (1 + dy)dy}{(y^2)^2} = 0$
 $2xy^2 dx + x^2 dy + dy^2 - 2y^3 dy = 0$
 divide by y
 $2xy dx + x^2 dy + dy^2 - 2y^2 dy = 0$
 $\therefore 2xy dx - 2y^2 dy + dy^2 = 0$ ans.

5. $x = A \sin(\omega t + \phi)$; ω & ϕ are parameters not to be elim.
 $\frac{dx}{dt} = A \omega \cos(\omega t + \phi)$
 $\frac{d^2x}{dt^2} = -A \omega^2 \sin(\omega t + \phi)$
 $= -A \omega^2 x$ (ans) ans.
 but $x = A \sin(\omega t + \phi)$
 $\frac{d^2x}{dt^2} = -\omega^2 x$
 $\therefore \frac{d^2x}{dt^2} + \omega^2 x = 0$ ans.

6. $x = C_1 \cos(\omega t) + C_2 \sin(\omega t)$
 ω is a parameter.
 $\frac{dx}{dt} = -C_1 \omega \sin(\omega t) + C_2 \omega \cos(\omega t)$
 $\frac{d^2x}{dt^2} = -C_1 \omega^2 \cos(\omega t) - C_2 \omega^2 \sin(\omega t)$
 $= -\omega^2 (C_1 \cos(\omega t) + C_2 \sin(\omega t))$
 $= -\omega^2 x$
 $\therefore \frac{d^2x}{dt^2} + \omega^2 x = 0$ ans.

7. $y = ax + b + c^2 + d$
 $a^2 dx + c^2 dx = 0 + c dy$
 $\therefore y^2 dx + c^2 dy = 0$ ans.

8. $y = ax + \frac{b}{x}$; a & b are parameters, to be eliminated.
 $y' = a - \frac{b}{x^2} \therefore a = y' + \frac{b}{x^2}$
 $\therefore y = (y' + \frac{b}{x^2})x + \frac{b}{x}$ ans.

9. $y^2 = 4ax$
 $2y dy = 4a dx$
 $\therefore 2a = \frac{2y dy}{dx}$
 substitute,
 $y^2 = \left(\frac{2y dy}{dx}\right)x$
 $y^2 dx = 2xy dy$
 $\therefore y^2 dx - 2xy dy = 0$ ans.

10. $y = ax^2 + bx + c$
 $y' = 2ax + b \therefore a = \frac{y' - b}{2}$
 $y'' = 2a \therefore a = \frac{y''}{2}$
 $y'' = 0$ ans.

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