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1. $\int \frac{3x-1}{(x-1)(x-2)(x-3)}$

$$= \frac{3x-1}{(x-1)(x-2)(x-3)} = \frac{A}{(x-1)} + \frac{B}{(x-2)} + \frac{C}{(x-3)}$$

$$\frac{3x-1}{(x-1)(x-2)(x-3)} = \frac{A(x-2)(x-3) + B(x-1)(x-3) + C(x-1)(x-2)}{(x-1)(x-2)(x-3)}$$

$$3x-1 = A(x-2)(x-3) + B(x-1)(x-3) + C(x-1)(x-2)$$

let $x=1$

$$3(1)-1 = A(1-2)(1-3)$$

$$3-1 = A(-1)(-2)$$

$$2 = 2A$$

$$\therefore A = 1$$

let $x=2$

$$3(2)-1 = B(2-1)(2-3)$$

$$6-1 = B(1)(-1)$$

$$5 = -B$$

$$\therefore B = -5$$

let $x=3$

$$3(3)-1 = C(3-1)(3-2)$$

$$9-1 = C(2)(1)$$

$$8 = 2C$$

$$\therefore C = 4$$

$$\int \frac{3x-1}{(x-1)(x-2)(x-3)} = \int \frac{1}{(x-1)} + \frac{-5}{(x-2)} + \frac{4}{(x-3)}$$

$$= \log(x-1) - 5 \log(x-2) + 4 \log(x-3) + C$$

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$$\frac{x^2+x+1}{(x+2)(x^2+1)}$$

$$x^2+x+1 = A(x^2+1) + (bx+c)(x+2)$$

let $x=-2$

$$(-2)^2 + (-2) + 1 = A((-2)^2 + 1)$$

$$4-2+1 = 5A \quad \therefore A = \frac{3}{5}$$

$$\text{let } x=0$$

$$1 = A(0+1) + (0+C)(0+2)$$

$$1 = A + 2C$$

$$1 = \frac{3}{5} + 2C$$

$$\therefore C = \frac{1}{5}$$

$$\text{let } x=1$$

$$1+1+1 = A(1^2+1) + (B+C)(1+2)$$

$$3 = A(2) + (B+C)(3)$$

$$3 = 2A + 3B + 3C$$

$$3 = 2\left(\frac{3}{5}\right) + 3B + 3\left(\frac{1}{5}\right)$$

$$3 - \frac{6}{5} - \frac{3}{5} = 3B$$

$$\frac{6}{5} = 3B$$

$$\therefore B = \frac{2}{5}$$

$$\frac{x^2+x+1}{(x+2)(x^2+1)} = \frac{A}{x+2} + \frac{Bx+C}{x^2+1}$$

$$\frac{x^2+x+1}{(x+2)(x^2+1)} = \int \frac{3}{5(x+2)} + \frac{1(x+1)}{5(x^2+1)}$$

$$= \frac{3}{5} \log(x+2) + \frac{1}{5} \log(x^2+1) + \frac{1}{5} \tan^{-1}(x) + C$$

$$3 \frac{(x^2+1)}{(x-3)(x-2)^2}$$

$$\frac{(x^2+1)}{(x-3)(x-2)^2} = \frac{A}{x-3} + \frac{B}{(x-2)^2} + \frac{C}{x-2}$$

$$\therefore x^2+1 = A(x-2)^2 + B(x-3) + C(x-2)(x-3)$$

$$\text{let } x=2$$

$$2^2+1 = B(2-3)$$

$$5 = -B$$

$$\therefore B = -5$$

$$\text{let } x=3$$

$$3^2+1 = A(3-2)^2$$

$$\therefore 10 = A$$

$$\text{let } x=1$$

$$1^2+1 = 10(1-2)^2 + (-5)(1-3) + C(1-2)(1-3)$$

$$2 = 10 + 10 + 2C$$

$$22 = 2C$$

$$\therefore C = 11$$

$$\int \frac{x^2+1}{(x-3)(x-2)^2} = \int \frac{10}{x-3} + \frac{-5}{(x-2)^2} + \frac{11}{x-2}$$

$$= 10 \log(x-3) + \frac{5}{x-2} + 11 \log(x-2) + C$$

4

$$\begin{array}{r} x^2 + 2x + 3 \\ x-1 \overline{) x^3 + x^2 + x + 1} \\ \underline{x^3 - x^2} \\ 2x^2 + x + 1 \\ \underline{2x^2 - 2x} \\ 3x + 1 \\ \underline{3x - 3} \\ 4 \end{array}$$

$$\int (x^2 + 2x + 3) dx + \int \frac{4}{x-1} dx$$

$$= \frac{x^3}{3} + x^2 + 3x + 4 \log(x-1) + C$$