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Date: 29 January 2026

EXERCISE 7.1

Find an anti derivative (or integral) of the following functions by the method of inspection.

1. $\sin 2x$
2. $\cos 3x$
3. e^{2x}
4. $(ax+b)^2$
5. $\sin 2x - 4e^{3x}$

Find the following integrals in Exercises 6 to 20:

6. $\int (4e^{3x}+1)\,dx$
7. $\int x^2\left(1-\frac{1}{x^2}\right)\,dx$
8. $\int (ax^2+bx+c)\,dx$
9. $\int (2x^2+e^x)\,dx$
10. $\int \left(\sqrt{x}-\frac{1}{\sqrt{x}}\right)^2\,dx$
11. $\int \frac{x^3+5x^2-4}{x^2}\,dx$
12. $\int \frac{x^3+3x+4}{\sqrt{x}}\,dx$
13. $\int \frac{x^3-x^2+x-1}{x-1}\,dx$
14. $\int (1-x)\sqrt{x}\,dx$
15. $\int \sqrt{x}(3x^2+2x+3)\,dx$

16. $\int (2x - 3\cos x + e^x)\,dx$
17. $\int (2x^2 - 3\sin x + 5\sqrt{x})\,dx$
18. $\int \sec x(\sec x + \tan x)\,dx$
19. $\int \frac{\sec^2 x}{\operatorname{cosec}^2 x}\,dx$
20. $\int \frac{2-3\sin x}{\cos^2 x}\,dx$

Choose the correct answer in Exercises 21 and 22.

21. The anti derivative of $(\sqrt{x} + \frac{1}{\sqrt{x}})$ equals:
(A) $\frac{1}{3}x^{\frac{1}{3}} + 2x^{\frac{1}{2}} + C$ (B) $\frac{2}{3}x^{\frac{2}{3}} + \frac{1}{2}x^2 + C$
(C) $\frac{2}{3}x^{\frac{3}{2}} + 2x^{\frac{1}{2}} + C$ (D) $\frac{3}{2}x^{\frac{3}{2}} + \frac{1}{2}x^{\frac{1}{2}} + C$

22. If $\frac{d}{dx}f(x) = 4x^3 - \frac{3}{x^4}$ such that $f(2) = 0$. Then $f(x)$ is:
(A) $x^4 + \frac{1}{x^3} - \frac{129}{8}$ (B) $x^3 + \frac{1}{x^4} + \frac{129}{8}$
(C) $x^4 + \frac{1}{x^3} + \frac{129}{8}$ (D) $x^3 + \frac{1}{x^4} - \frac{129}{8}$

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EXERCISE 7.2

Integrate the functions in Exercises 1 to 37:

1. $\frac{2x}{1+x^2}$
2. $\frac{(\log x)^2}{x}$
3. $\frac{1}{x+x\log x}$
4. $\sin x \sin(\cos x)$
5. $\sin(ax+b)\cos(ax+b)$
6. $\sqrt{ax+b}$
7. $x\sqrt{x+2}$
8. $x\sqrt{1+2x^2}$
9. $(4x+2)\sqrt{x^2+x+1}$
10. $\frac{1}{x-\sqrt{x}}$
11. $\frac{x}{\sqrt{x+4}}, x > 0$
12. $(x^3-1)^{\frac{1}{3}}x^5$
13. $\frac{x^2}{(2+3x^3)^3}$
14. $\frac{1}{x(\log x)^m}, x > 0, m \neq 1$
15. $\frac{x}{9-4x^2}$
16. e^{2x+3}

17. $\frac{x}{e^{x^2}}$
18. $\frac{e^{\tan^{-1}x}}{1+x^2}$
19. $\frac{e^{2x}-1}{e^{2x}+1}$
20. $\frac{e^{2x}-e^{-2x}}{e^{2x}+e^{-2x}}$
21. $\tan^2(2x-3)$
22. $\sec^2(7-4x)$
23. $\frac{\sin^{-1}x}{\sqrt{1-x^2}}$
24. $\frac{2\cos x-3\sin x}{6\cos x+4\sin x}$
25. $\frac{1}{\cos^2 x(1-\tan x)^2}$
26. $\frac{\cos\sqrt{x}}{\sqrt{x}}$
27. $\sqrt{\sin 2x}\cos 2x$
28. $\frac{\cos x}{\sqrt{1+\sin x}}$
29. $\cot x \log \sin x$
30. $\frac{\sin x}{1+\cos x}$
31. $\frac{\sin x}{(1+\cos x)^2}$
32. $\frac{1}{1+\cot x}$
33. $\frac{1}{1-\tan x}$
34. $\frac{\sqrt{\tan x}}{\sin x\cos x}$
35. $\frac{(1+\log x)^2}{x}$
36. $\frac{(x+1)(x+\log x)^2}{x}$
37. $\frac{x^3\sin(\tan^{-1}x^4)}{1+x^8}$

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Summary

Integration is the inverse process of differentiation. In the differential calculus, we are given a function and we have to find the derivative or differential of this function, but in the integral calculus, we are to find a function whose differential is given.
Let $\frac{d}{dx}F(x) = f(x)$. Then we write $\int f(x)\,dx = F(x) + C$. These integrals are called indefinite integrals or general integrals, C is called constant of integration. All these antiderivatives differ by as constant.

Properties of Indefinite Integrals:

1. $\int [f(x) + g(x)]\,dx = \int f(x)\,dx + \int g(x)\,dx$
2. For any real number k, $\int k f(x)\,dx = k \int f(x)\,dx$
3. $\int [k_1 f_1(x) + k_2 f_2(x) + \cdots + k_n f_n(x)]\,dx = k_1 \int f_1(x)\,dx + \cdots + k_n \int f_n(x)\,dx$

Standard Integrals:

1. $\int x^n\,dx = \frac{x^{n+1}}{n+1} + C, (n \neq -1)$
2. $\int \frac{1}{x}\,dx = \log|x| + C$
3. $\int \cos x\,dx = \sin x + C$
4. $\int \sin x\,dx = -\cos x + C$
5. $\int \sec^2 x\,dx = \tan x + C$
6. $\int \text{cosec}^2 x\,dx = -\cot x + C$
7. $\int \sec x \tan x\,dx = \sec x + C$
8. $\int \text{cosec} x \cot x\,dx = -\text{cosec} x + C$
9. $\int \frac{dx}{\sqrt{1-x^2}} = \sin^{-1} x + C$
10. $\int \frac{dx}{1+x^2} = \tan^{-1} x + C$
11. $\int e^x\,dx = e^x + C$
12. $\int a^x\,dx = \frac{a^x}{\log a} + C$

Integration by Partial Fractions:

1. $\frac{px+q}{(x-a)(x-b)} = \frac{A}{x-a} + \frac{B}{x-b}, a \neq b$
2. $\frac{px+q}{(x-a)^2} = \frac{A}{x-a} + \frac{B}{(x-a)^2}$
3. $\frac{px^2+qx+r}{(x-a)(x-b)(x-c)} = \frac{A}{x-a} + \frac{B}{x-b} + \frac{C}{x-c}$
4. $\frac{px^2+qx+r}{(x-a)^2(x-b)} = \frac{A}{x-a} + \frac{B}{(x-a)^2} + \frac{C}{x-b}$
5. $\frac{px^2+qx+r}{(x-a)(x^2+bx+c)} = \frac{A}{x-a} + \frac{Bx+C}{x^2+bx+c}$

Integrals of Special Functions:

1. $\int \frac{dx}{x^2-a^2} = \frac{1}{2a} \log\left|\frac{x-a}{x+a}\right| + C$
2. $\int \frac{dx}{a^2-x^2} = \frac{1}{2a} \log\left|\frac{a+x}{a-x}\right| + C$
3. $\int \frac{dx}{x^2+a^2} = \frac{1}{a} \tan^{-1} \frac{x}{a} + C$
4. $\int \frac{dx}{\sqrt{x^2-a^2}} = \log\left|x + \sqrt{x^2 - a^2}\right| + C$
5. $\int \frac{dx}{\sqrt{a^2-x^2}} = \sin^{-1} \frac{x}{a} + C$
6. $\int \frac{dx}{\sqrt{x^2+a^2}} = \log\left|x + \sqrt{x^2 + a^2}\right| + C$

Fundamental Theorem of Integral Calculus:

1. **First Fundamental Theorem:** Let $A(x) = \int_a^x f(t)\,dt$, then $A'(x) = f(x)$.
2. **Second Fundamental Theorem:** $\int_a^b f(x)\,dx = [F(x)]_a^b = F(b) - F(a)$.

Integration by parts:

$\int f_1(x) \cdot f_2(x)\,dx = f_1(x) \int f_2(x)\,dx - \int \left[f_1'(x) \cdot \int f_2(x)\,dx\right]\,dx$
Also, $\int e^x [f(x) + f'(x)]\,dx = e^x f(x) + C$