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## NCERT Class 11 Mathematics Solutions: Chapter 13 – Limits and Derivatives Miscellaneous Exercise Part 10

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### Basic Differentiation Rules for Elementary Functions

$$1. \frac{d}{dx}[cu] = cu'$$

$$2. \frac{d}{dx}[u \pm v] = u' \pm v'$$

$$3. \frac{d}{dx}[uv] =$$

$$4. \frac{d}{dx}\left[\frac{u}{v}\right] = \frac{vu' - uv'}{v^2}$$

$$5. \frac{d}{dx}[c] = 0$$

$$6. \frac{d}{dx}[u^n] =$$

$$7. \frac{d}{dx}[x] = 1$$

$$8. \frac{d}{dx}[|u|] = \frac{u}{|u|}(u'), \quad u \neq 0$$

$$9. \frac{d}{dx}[\ln u] =$$

$$10. \frac{d}{dx}[e^u] = e^u u'$$

$$11. \frac{d}{dx}[\log_a u] = \frac{u'}{(\ln a)u}$$

$$12. \frac{d}{dx}[a^u] =$$

$$13. \frac{d}{dx}[\sin u] = (\cos u)u'$$

$$14. \frac{d}{dx}[\cos u] = -(\sin u)u'$$

$$15. \frac{d}{dx}[\tan u] =$$

$$16. \frac{d}{dx}[\cot u] = -(\csc^2 u)u'$$

$$17. \frac{d}{dx}[\sec u] = (\sec u \tan u)u'$$

$$18. \frac{d}{dx}[\csc u] =$$

$$19. \frac{d}{dx}[\arcsin u] = \frac{u'}{\sqrt{1-u^2}}$$

$$20. \frac{d}{dx}[\arccos u] = \frac{-u'}{\sqrt{1-u^2}}$$

$$21. \frac{d}{dx}[\arctan u] =$$

$$22. \frac{d}{dx}[\operatorname{arccot} u] = \frac{-u'}{1+u^2}$$

$$23. \frac{d}{dx}[\operatorname{arcsec} u] = \frac{u'}{|u|\sqrt{u^2-1}}$$

$$24. \frac{d}{dx}[\operatorname{arccsc} u] =$$

1. Find the derivative of the following functions (it is to be understood that  $a, b, c, d, p, q, r$  and  $s$  are fixed non-zero constants and  $m$  and  $n$  are integers):  $\frac{a+b \sin x}{c+d \cos x}$

Answer:

$$f(x) = \frac{a + b \sin x}{c + d \cos x}$$

By quotient rule,

$$\begin{aligned} f'(x) &= \frac{(c + d \cos x) \frac{d}{dx}(a + b \sin x) - (a + b \sin x) \frac{d}{dx}(c + d \cos x)}{(c + d \cos x)^2} \\ &= \frac{(c + d \cos x)(b \cos x) - (a + b \sin x)(-d \sin x)}{(c + d \cos x)^2} \\ &= \frac{cb \cos x + bd \cos^2 x + ad \sin x + bd \sin^2 x}{(c + d \cos x)^2} \\ &= \frac{bc \cos x + ad \sin x + bd(\cos^2 x + \sin^2 x)}{(c + d \cos x)^2} \\ &= \frac{bc \cos x + ad \sin x + bd}{(c + d \cos x)^2} \end{aligned}$$

2. Find the derivative of the following functions (it is to be understood that  $a, b, c, d, p, q, r$ , and  $s$  are fixed non-zero constants and  $m, n$  are integers):  $\frac{\sin(x+a)}{\cos x}$

Answer:

$$f(x) = \frac{\sin(x+a)}{\cos x}$$

By quotient rule,

$$\begin{aligned} f'(x) &= \frac{\cos x \frac{d}{dx}[\sin(x+a)] - \sin(x+a) \frac{d}{dx} \cos x}{\cos^2 x} \\ f'(x) &= \frac{\cos x \frac{d}{dx}[\sin(x+a)] - \sin(x+a)(-\sin x)}{\cos^2 x} \quad \dots \text{eq (1)} \\ g(x) &= \sin(x+a) \end{aligned}$$

Accordingly,

$$g(x+h) = \sin(x+h+a)$$

By principle,

$$\begin{aligned} g'(x) &= \lim_{h \rightarrow 0} \frac{g(x+h) - g(x)}{h} \\ &= \lim_{h \rightarrow 0} \frac{1}{h} [\sin(x+h+a) - \sin(x+a)] \\ &= \lim_{h \rightarrow 0} \frac{1}{h} \left[ 2 \cos \left( \frac{x+h+a+x+a}{2} \right) \sin \left( \frac{x+h+a-x-a}{2} \right) \right] \\ &= \lim_{h \rightarrow 0} \frac{1}{h} \left[ 2 \cos \left( \frac{2x+2a+h}{2} \right) \sin \left( \frac{h}{2} \right) \right] \\ &= \lim_{h \rightarrow 0} \left[ \cos \left( \frac{2x+2a+h}{2} \right) \left\{ \frac{\sin \left( \frac{h}{2} \right)}{\left( \frac{h}{2} \right)} \right\} \right] \\ &= \lim_{h \rightarrow 0} \cos \left( \frac{2x+2a+h}{2} \right) \cdot \lim_{h \rightarrow 0} \left\{ \frac{\sin \left( \frac{h}{2} \right)}{\left( \frac{h}{2} \right)} \right\} \quad [\text{As } h \rightarrow 0 \Rightarrow \frac{h}{2} \rightarrow 0] \\ &= \left( \cos \frac{2x+2a}{2} \right) \times 1 \left[ \lim_{h \rightarrow 0} \frac{\sin h}{h} = 1 \right] \\ &= \cos(x+a) \quad \dots \text{eq (2)} \end{aligned}$$

From eq (1) and (2),

$$\begin{aligned} f'(x) &= \frac{\cos x \cos(x+a) + \sin x \sin(x+a)}{\cos^2 x} \\ &= \frac{\cos(x+a-x)}{\cos^2 x} \\ &= \frac{\cos a}{\cos^2 x} \end{aligned}$$