BAAP OF ALL FORMULA LISTS

FOR IIT JEE

DIFFERENTIAL CALCULUS

SL#	FORMULA
1	**Even Function** $F(-x) = f(x)$
2	**Odd Functin** $f(-x) = -f(x)$
3	**Periodic Function** $f(x + nT) = f(x)$
4	**Inverse Function** $y = f(x)$ **is any function** $x = g(y)$ **or** $y = f^{-1}(x)$ **is its inverse function.**
5	**Composite Functin** $y = f(u), u = g(x), y = f(g(x))$ **is a composite function.**
6	**Linear Function** $y = ax + b, x \in R, a = \tan\alpha$ **is the slope of the line, b is the y-intercept.**
7	**Quadratic Function** $y = x^2, x\varepsilon R.$ $y = ax^2 + bx + c, x\varepsilon R.$
8	**Cubic Function** $y = x^3, x\varepsilon R$ $y = ax^3 + bx^2 + cx + d, x\varepsilon R$
9	**Power Function** $y = x^n, n\varepsilon N.$
10	**Square Root function** $y = \sqrt{x}, x\varepsilon[0, \infty).$
11	**Exponential Functions** $y = a^x, a > 0, a \neq 1, y = e^x$ **if** $a = e, e = 2.71828182846.........$
12	**Logarithmic Functions** $y = \log_a x, x\varepsilon(0, \infty), a > 0, a \neq 1, y = \ln x$ **if** $a = e, x > 0$
13	**Hyperbolic Sine Function** $y = \sinh x, \sinh x = \frac{e^x - e^{-x}}{2}, x\varepsilon R.$
14	**Hyperbolic Cosine Function** $y = \cosh x, \cosh x = \frac{e^x + e^{-x}}{2}, x\varepsilon R.$
15	**Hyperbolic Tangent Function**

	$y = \tanh x, y = \tanh x = \frac{\sinh x}{\cosh x} = \frac{e^x - e^{-x}}{e^x + (e^{-x})}, x\varepsilon R.$
16	**Hyperbolic Cotangent Function** $y = \cot hx, y = \coth x = \frac{\cosh x}{\sinh x} = \frac{e^x + e^{-x}}{e^x - e^{-x}}, x\varepsilon R, x \neq 0$
17	**Hyperbola Secant Function** $y = \operatorname{sech} x, y = \operatorname{sech} x = \frac{1}{\cosh x} = \frac{2}{e^x + e^{-x}}, x\varepsilon R.$
18	**Hyperbolic Cosecant Function** $y = \cos echx, y = \cos echx = \frac{1}{\sinh x} = \frac{2}{e^x - e^{-x}}, x\varepsilon R, x \neq 0$
19	**Inverse Hyperbolic Sine Function** $y = \sin^{-1} hx, x\varepsilon R.$
20	**Inverse Hyperbolic cosine Function** $yi = \cos^{-1} hx, x\varepsilon[1, \infty).$
21	**Inverse Hyperbolic Tangent Function** $y = \tan^{-1} hx, x\varepsilon(-1, 1).$
22	**Inverse Hyperbolic Contagent Function** $y = \cot^{-1} hx, x\varepsilon(-\infty, -1) \cup (1, \infty).$
23	**Inverse Hyperbola Secant Function** $y = \sec^{-1} hx, x\varepsilon(0, 1].$
24	**Inverse Hyperbolic Cosecant Function** $y = \cos^{-1} echx, x\varepsilon R, x \neq 0$
25	$\lim_{x \to a} [f(x) + g(x)] = \lim_{x \to a} f(x) + \lim_{x \to a} g(x)$
26	$\lim_{x \to a} [f(x) - g(x)] = \lim_{x \to a} f(x) - \lim_{x \to a} g(x)$
27	$\lim_{x \to a} [f(x).\, g(x)] = \lim_{x \to a} f(x).\ \lim_{x \to a} g(x)$
28	$\lim_{x \to a} \left(\frac{f(x)}{g(x)}\right) = \frac{\lim_{x \to a} f(x)}{\lim_{x \to a} g(x)}$ if $\lim_{x \to a} g(x) \neq 0.$
29	$\lim_{x \to a} [kf(x)] = k \lim_{x \to a} f(x)$
30	$\lim_{x \to a} f(g(x)) = f\left(\lim_{x \to a} g(x)\right)$
31	$\lim_{x \to a} f(x) = f(a)$ **if the function** $f(x)$ **is continuous at x=a**
32	$\lim_{x \to 0} \frac{\sin x}{x} = 1$
33	$\lim_{x \to 0} \frac{\tan x}{x} = 1$

34	$\lim_{x \to 0} \frac{\sin^{-1} x}{x} = 1$
35	$\lim_{x \to 0} \frac{\tan^{-1} x}{x} = 1$
36	$\lim_{x \to 0} \frac{\ln(1+x)}{x} = 1$
37	$\lim_{x \to \infty} \left(1 + \frac{1}{x}\right)^x = e$
38	$\lim_{x \to \infty} \left(1 + \frac{k}{x}\right)^x = e^k$
39	$\lim_{x \to 0} a^x = 1$

40	$y'(x) = \lim_{\triangle x \to 0} \frac{f(x + \triangle x) - f(x)}{\triangle x} = \lim_{\delta x \to 0} \frac{\triangle y}{\triangle x} = \frac{dy}{dx}$
41	$\frac{dy}{dx} = \tan \alpha$
42	$\frac{d(u+v)}{dx} = \frac{du}{dx} + \frac{dv}{dx}$
43	$\frac{d(u-v)}{dx} = \frac{du}{dx} + \frac{dv}{dx}$
44	$\frac{d(ku)}{dx} = k\frac{du}{dx}$
45	**Product Rule** $\frac{d(u.v)}{dx} = \frac{du}{dx}.v + u.\frac{dv}{dx}$
46	**Chain Rule** $y = f(g(x)), y = g(x), \frac{dy}{dx} = \frac{dy}{dg}.\frac{dg}{dx}$
47	**Derivative of Inverse function** $\frac{dy}{dx} = \frac{1}{\frac{dx}{dy}}$ **where $x(y)$ is the inverse function of $y(x)$.**

48	**Reciprocal Rule** $\frac{d}{dx}\left(\frac{1}{y}\right) = -\frac{\frac{dy}{dx}}{y^2}$
49	**Logarithmic Differentiation** $y = f(x), \ln y = \ln f(x), \frac{dy}{dx} = f(x).\frac{d}{dx}[\ln f(x)]$
50	$\frac{d}{dx}(C) = 0$
51	$\frac{d}{dx}(x) = 1$
52	$\frac{d}{dx}(ax+b) = a$
53	$\frac{d}{dx}(ax^2 + bx + c) = 2ax + b$

54	$\frac{d}{dx}(x^n) = nx^{n-1}$
55	$\frac{d}{dx}x^{-n} = -\frac{n}{x^{n+1}}$

56	$\frac{d}{dx}\left(\frac{1}{x}\right) = -\frac{1}{x^2}$
57	$\frac{d}{dx}(\sqrt{x}) = \frac{1}{2\sqrt{x}}$
58	$\frac{d}{dx}(\sqrt[n]{x}) = \frac{1}{n\sqrt[n]{x^{n-1}}}$
59	$\frac{d}{dx}(\ln x) = \frac{1}{x}$
60	$\frac{d}{dx}(\log_a x) = \frac{1}{x 1na}, a > 0, a \neq 1.$
61	$\frac{d}{dx}(e^x) = e^x$
62	$\frac{d}{dx}(\sin x) = \cos x$
63	$\frac{d}{dx}(\cos x) = -\sin x$

64	$\frac{d}{dx}(\tan x) = \frac{1}{\cos^2 x} = \sec^2 x$
65	$\frac{d}{dx}(\cot x) = \frac{1}{\sin^2 x} = \cos ec^2 x$
66	$\frac{d}{dx}(\sec x) = \tan x. \sec x$
67	$\frac{d}{dx}(\cos ecx) = -\cot x. \cos ecx$
68	$\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$
69	$\frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}$
70	$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$
71	$\frac{d}{dx}(\cot^{-1} x) = -\frac{1}{1+x^2}$

72	$\frac{d}{dx}(\sec^{-1} x) = \frac{1}{\lvert x \rvert \sqrt{x^2-1}}$
73	$\frac{d}{dx}(\cos^{-1} ecx) = -\frac{1}{\lvert x \rvert \sqrt{x^2-1}}$
74	

	$\frac{d}{dx}(\sinh x) = \cos hx$
75	$\frac{d}{dx}(\cosh x) = \sinh x$
76	$\frac{d}{dx}(\tanh x) = \frac{1}{\cosh^2 x} = \text{sech}^2 x$
77	$\frac{d}{dx}(\coth x) = -\frac{1}{\sinh^2 x} = \text{sech}^2 x$
78	$\frac{d}{dx}(\text{sech}\, x) = -\text{sech}\, x.\tanh x$
79	$\frac{d}{dx}(\cos echx) = -\cos echx.\coth x$

80	$\frac{d}{dx}(\sin^{-1} hx) = \frac{1}{\sqrt{x^2+1}}$
81	$\frac{d}{dx}(\cos^{-1} hx) = \frac{1}{\sqrt{x^2-1}}$
82	$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1-x^2}, \lvert x \rvert < 1$
83	$\frac{d}{dx}(\cot^{-1} hx) = -\frac{1}{x^2-1}, \lvert x \rvert > 1$
84	$\frac{d}{dx}(u^v) = vu^{v-1}.\frac{du}{dx} + u^v \ln u.\frac{dv}{dx}$
85	**Second derivative** $f'' = (f')' = \frac{dy}{dx}' = \frac{d}{dx} = \frac{d^2y}{dx^2}$
86	**Higher-Order derivative** $f^n = \frac{d^ny}{dx^n} = y^n = (f^{n-1})$
87	$(u+v)^n = u^n + v^n$

88	$(u-v)^n = u^n - v^n$
89	**Leibnitz\'s formulas** $(uv)'' = u''v + 2u'v' + uv'', (uv)''' + u'''v + 3u''v' + 3u'v'' + uv''', (uv)^n = u^nv + \nu^{n-1}v' + \frac{n(n-1)}{1.2}u^{n-2}v'' + \ldots + uv^n$
90	$(x^m)^n = \frac{m!}{m-n}!x^{m-n}$
91	$(x^n)^n = n!$
92	$(\log_a x)^a = \frac{(-1)^{n-1}(n-1)!}{x^n 1na}$
93	$(\ln x)^n = \frac{(-1)^{n-1}(n-1)!}{x^n}$
94	$(a^x)^n = a^x \ln^n a$
95	$(e^x)^n = e^x$

96	$(a^{mx})^n = m^n a \cdot (mx) 1n^n a$
97	$(\sin x)^n = \sin\left(x + \frac{n\pi}{2}\right)$
98	$(\cos x)^n = \cos\left(x + \frac{n\pi}{2}\right)$
99	**Velocity and Acceleration** $s = f(t)$ is the position of an object relative to a fixed coordinate system at a time t, $v = s' = f'(t)$ is the instantaneous velocity of the object $w = v' = s'' = f''(t)$ is the intantaneous acceleration of the object.
100	**Tangent Line** $y - y_0 = f'(x_0)(x - x_0)$
101	**Normal Line** $y - y_0 = -\frac{1}{f'(x_0)(x - x_0)}$
102	**Increasing and Decreasing Functions.** If $f'(x_0) > 0$, then $f(x)$ is increasing at x_0. If $f'(x_0) < 0$, then $f(x)$ is decreasing at x_0.
103	If $f'(x_0)$ does not exist or is zero, then the test fails.
104	**Local extrema** A function $f(x)$ has as local maximum at x_1 if and only if there exists some interval containing x_1 such that $f(x_1) \geq f(x)$ for all x in the interval. A function $f(x)$ has a local minimum at x_2 if and only if there exists some interval contaiing x_2 such that $f(x_2) \leq f(x)$ for all x in the interval.
105	**Cirtical Points** A critical points on $f(x)$ occurs at x_0 if and only if either $f'(x_0)$ is zero or the derivative doesn\'t exist.
106	**First Derivative Test for Local extrema** If $f(x)$ is increasing $(f'(x) > 0$ for all x in some interval $(a, x_1]$ and $f(x)$ is decreasing $(f'(x) < 0)$ for all x in some interval $[x_1, b)$, then $f(x)$ has a local maximum at x_1.
107	If $f(x)$ is decreasing $(f'(x) < 0)$ for all x in some interval $(a, x_{20}$ and $f(x)$ is increasing $(f'(x) > 0)$ for all x in some interval $[x_2, b)$, then $f(x)$ has a local minimum at x_2.
108	**Second Derivative Test for local Extrema** If $f'(x_1) = 0$ and $f''(x_1) < 0$, then $f(x)$ has a local maximum at x_1. If $f'(x_2) = 0$ and $f''(x_2) > 0$, then $f(x)$ has a local minimum at x_2.
109	**Concavity** $f(x)$ is concave upward at x_0 if and only if $f'(x)$ is increasing at $x_0 f(x)$ is concave downward at x_0 if and only if $f'(x)$ is decreasing at x_0.
110	**Second Derivative Test for Concavity** If $f''(x_0) > 0$, then $f(x)$ is concave upward at x_0, If $f''(x_0) < 0$, then $f(x)$ is concave downward at x_0, If $f''(x)$ does not exist or is zero, then the test fails.
111	**Inflection Points** If $f'(x_3)$ exists and $f''(x)$ changes sign at $x = x_3$, then the point $(x_3, f(x_3))$ is an inflection point of the graph of $f(x)$ If $f''(x_3)$ exists at the inflection point, then $f''(x_3) = 0$
112	**L\' Hopital\'s Rule**

	$\lim_{x \to c} \frac{f(x)}{g(x)} = \lim_{x \to c} \frac{f'(x)}{g'(x)}$ if $\lim_{x \to c} f(x) = \lim_{x \to c} g(x) = \begin{cases} 0 \\ . \\ \infty \end{cases}$
113	$dy = y'dx$
114	$f(x + \triangle x) = f(x) + f'(x) \triangle x$
115	**Small Change in** $y \triangle y = f(x + \triangle x) - f(x)$
116	$d(u + v) = du + dv$
117	$d(u - v) = du - dv$
118	$d(Cu) = Cdu$
119	$d(uv) = vdu + udv$

120	$d\left(\frac{u}{v}\right) = \frac{vdu - udv}{v^2}$
121	**First Order Partial Derivatives** **The partial derivative with respect to** x $\frac{\partial f}{\partial x} = f_x \left(also \frac{\partial z}{\partial x} = z_x\right)$, **The partial derivative with respect to** y $\frac{\partial f}{\partial y} = f_y \left(also \frac{\partial z}{\partial y} = z_y\right)$.
122	**Second Order Partial Derivatives** $\frac{\partial}{\partial x} \frac{\partial f}{\partial x} = (\partial^2 f)(\partial x^2) = f_{\times}, \frac{\partial}{\partial y} \frac{\partial^2 f}{\partial y^2} = f_{yy}, patial\left(\partial y\left(\frac{\partial f}{\partial x} = \frac{\partial^2 f}{\partial y \partial x} = f_{xy}, \partial(\partial x)\left(\frac{\partial f}{\partial y} = \frac{\partial^2 f}{\partial x \partial y} = f_{yx}.\right.\right.\right.$ **If the derivatives are continuous, then** $\frac{\partial f}{\partial y \partial x} = \frac{\partial^2 f}{\partial x \partial y}$.
123	**Chain Rules** **If** $f(x, y) = g(h(x, y))$(**g is a function of one variable h), then** $\frac{\partial f}{\partial x} = g'(h(x, y)) \frac{\partial h}{\partial x}, \frac{\partial f}{\partial y} = g(h(x, y)) \frac{\partial h}{\partial y}$. **If** $h(t) = f(x(t), y(t))$,**then** $h'(t) = \frac{\partial f}{\partial x} \frac{dx}{dt} + \frac{\partial f}{\partial y} \frac{dy}{dt}$. **I** $z = f(x(u, v), y(u, v)0$ **then** $\frac{\partial z}{\partial u} = \frac{\partial f}{\partial x} \frac{\partial x}{\partial u} + \frac{\partial f}{\partial y} \frac{\partial y}{\partial u}, \frac{\partial z}{\partial v} = \frac{\partial f}{\partial} x\Big) \frac{\partial x}{\partial v} + \frac{\partial f}{\partial y} \frac{\partial y}{\partial v}$.
124	**Small Changes** $\triangle \approx \left(\frac{\partial f}{\partial x}\right)x + \left(\frac{\partial f}{\partial y}\right)y.$
125	**Local Maxima and Minima** $f(x, y)$ **has a local maximum at** (x_0, y_0) **if** $f(x, y) \leq f(x_0, y_0)$ **for all** (x, y) **sufficiently close to** $(x_0, y_0) f(x, y)$ **has a local minimum at** (x_0, y_0) **if** $f(x, y) \geq f(x_0, y_0) f \text{ or } all(x, y)$ **sufficiently close** (x_0, y_0).
126	**Saddle Point** **A stationary point which is neither a local maximum nor a local minimum**
127	**Stationary Points** $\frac{\partial f}{\partial x} = \frac{\partial f}{\partial y} = 0$ **Local maxima and local minima occur at stationary points.**

128	**Tangent Plane** **The equation of the tangent plane to the surface** $z = f(x, y) at (x_0, y_0, z_0)$ **is** $z - z_0 = f_x(x_0, y_0)(x - x_0) + f_y(x_0, y_0)(y - y_0)$

129	**Normal to Surface** **The equationn of the normal to the surface** $z = f(x, y)$ **at** (x_0, y_0, z_0) **is** $\frac{x - x_0}{f_x(x_0, y_0)} = \frac{y - y_0}{f_y(x_0, y_0)} = \frac{z - z_0}{-1}$
130	**Gradient of a Scalar Function** $\nabla f = \nabla f = \left(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial f}{\partial z}\right)$ $\nabla u = \nabla u = \left(\frac{\partial u}{\partial x_1}, \frac{\partial u}{\partial x_2}, \dots\dots, \frac{\partial u}{\partial x_n}\right)$
131	**Directional Derivative** $\frac{\partial f}{\partial 1} = \frac{\partial f}{\partial x}\cos\alpha + \frac{\partial f}{\partial y}\cos\beta + \frac{\partial f}{\partial z}\cos\gamma,$ **where the direction is defined by the vector** $\overrightarrow{1}(\cos\alpha, \cos\beta, \cos\gamma), \cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1.$
132	**Divergence of a Vector Field** $\div \overrightarrow{F} \equiv \nabla . \overrightarrow{F} = \frac{\partial P}{\partial x} + \frac{\partial Q}{\partial y} + \frac{\partial R}{\partial z}$
133	**Laplacian Operator** $\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}$
134	$\div\left(curl\overrightarrow{F}\right) = \nabla . \left(\nabla \times \overrightarrow{F}\right) = 0$
135	$curl(\nabla f) = \nabla \times (v \nabla f) \equiv 0$
136	$\div(\nabla f) = \nabla . (\nabla) = \nabla^2 f$
137	$curl\left(curl\overrightarrow{F}\right) \equiv \nabla\left(\div\overrightarrow{F}\right) - \nabla\overrightarrow{F} - \nabla\left(\nabla . \overrightarrow{F}\right) - \nabla^2\overrightarrow{F}.$