1. $\frac{dk}{dx} = 0$
2. $x = 1$
3. $x^2 = 2x$
4. $x^3 = 3x^2$
5. $x^n = n\,x^{n-1}$
6. $\frac{1}{x^n} = \frac{-n}{x^{n+1}}$
7. $\frac{1}{x} = -\frac{1}{x^2}$
8. $\frac{1}{x^2} = -\frac{2}{x^3}$
9. $\frac{1}{x^3} = -\frac{3}{x^4}$
10. $\log x = \frac{1}{x}$
11. $\sqrt{x} = \frac{1}{2\sqrt{x}}$
12. $e^{ax} = ae^{ax}$
13. $e^x = e^x$
14. $e^{ax} = ae^{ax}$
15. $e^{-x} = -e^{-x}$
16. $e^{-2x} = -2e^{-2x}$
17. $e^{3x} = 3e^{3x}$
18. $a^x = a^x \log a$
19. $2^x = 2^x \log 2$
20. $3^x = 3^x \log 3$
21. $\frac{d(\sin ax)}{dx} = a\cos ax$
22. $\frac{d(\sin x)}{dx} = \cos x$
23. $\frac{d(\cos ax)}{dx} = -a\sin ax$
24. $\frac{d(\cos x)}{dx} = -\sin x$
25. $\frac{d(\tan ax)}{dx} = a\sec^2 x$
26. $\frac{d(\tan x)}{dx} = \sec^2 x$
27. $\frac{d(\cos ecax)}{dx} = -a\cos ecax\cot ax$
28. $\frac{d(\cos ecx)}{dx} = -\cos ecx\cot x$
29. $\frac{d(\sec ax)}{dx} = a\sec ax.\tan ax$
30. $\frac{d(\sec x)}{dx} = \sec x\tan x$
31. $\frac{d(\cot ax)}{dx} = -a\cos ec^2 ax$
32. $\frac{d(\cot x)}{dx} = -\cos ec^2 x$

RULES OF DIFFERETIATION

1. ALGEBRAIC RULE

$y = u + v$

$\frac{dy}{dx} = \frac{du}{dx} + \frac{dv}{dx}$

2. PRODUCT RULE

$y = uv$

$\frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$

$\frac{dy}{dx} = uv^1 + vu^1$

3. QUOTIENT RULE

$y = \frac{u}{v}$

$\frac{dy}{dx} = \frac{vu^1 - uv^1}{v^2}$

4. CHAIN RULE

1. $\frac{d(f(x))^n}{dx} = n(f(x))^{n-1} f^1(x)$
2. $\frac{d(\sqrt{f(x)})}{dx} = \frac{1}{2\sqrt{f(x)}} f^1(x)$
3. $\frac{d(\log f(x))}{dx} = \frac{1}{f(x)} f^1(x)$
4. $\frac{d(\sin(f(x)))}{dx} = \cos(f(x)) f^1(x)$

MAIN PROBLEMS ON CHAIN RULE

1. $\frac{d(\sin^2 x)}{dx} = 2\sin x\cos x$
2. $\frac{d(\cos^2 x)}{dx} = 2\cos x(-\sin x)$
3. $\frac{d(\tan^2 x)}{dx} = 2\tan x(\sec^2 x)$

4. $\frac{d(\sin^3 x)}{dx} = 3\sin^2 x.\cos x$

5. $\frac{d(\cos^3 x)}{dx} = 3\cos^2 x(-\sin x)$

6. $\frac{d(\tan^3 x)}{dx} = 3\tan^2 x(\sec^2 x)$

7. $\frac{d(\sqrt{\sin x})}{dx} = \frac{1}{2\sqrt{\sin x}}\cos x$

IMPLICIT FUNCTIONS

1. $y = y^1$
2. $y^2 = 2yy^1$
3. $y^3 = 3y^2y^1$
4. $y^4 = 4y^3y^1$
5. $xy = (xy^1 + y)$
6. $x^2y = (x^2y^1 + y(2x))$
7. $x^2y^2 = x^2(2yy^1) + y^2(2x)$
8. $3xy = 3(xy^1 + y)$
9. $3x^2y = 3(x^2y^1 + y(2x))$
10. $\sin y = \cos y\,.\,y^1$

PARAMETRIC DIFFERENTIATION

$x = f(t), \quad y = g(t)$

then

$$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$$

1. $x = at, \quad y = \frac{a}{t}$
2. $x = a\sin^2 t, \quad y = b\cos^2 t$
3. $x = a\sin^3 t, \quad y = b\cos^3 t$
4. $x = a(\sin\theta - \cos\theta),$
   $y = b(\theta + \sin\theta)$

LOGARITHEMIC DIFFERENTIATION

$\log a^m = m\log a$

$\log mn = \log m + \log n$

$y = f(x)^{g(x)}$

applying log *on both sides*

$\log y = \log f(x)^{g(x)}$

$\log y = g(x)\log f(x)$

$y = x^x, \quad y = \sin x^{\cos x}, \quad y = \cos x^{\sin x}$

$y = \tan x^{\sin x}, \quad y = \log x^{\sin s}, \quad y = \sin x^{\log x}$

SUCCESSIVE DIFFERNTIATION

Differentiating twice

APPLICATION OF DIFFERENTIATION

1. **Formula for slope of a tangent**
   $m = \frac{dy}{dx} = \tan\theta$
2. **Slope of a normal**
   $N = -\frac{1}{m} = -\frac{1}{\frac{dy}{dx}}$
3. **Equation of a tangent**
   $y - y_1 = m(x - x_1)$
4. **Equation of normal**
   $y - y_1 = \frac{1}{-m}(x - x_{1)}$
5. **Velocity**
   $v = \frac{dy}{dx}$
6. **Acceleration**
   $a = \frac{d^2y}{dx^2} = differentiating\ twice$
7. **Area of circle,** $A = \pi r^2, \frac{dA}{dt} = 2\pi r$ **,**
8. **Volume of a sphere ,**
   $V = \frac{4}{3}\pi r^3, \frac{dV}{dt} = 4\pi r^2\frac{dr}{dt}$
9. **Area of squre,** $A = a \times a$
10. **Area of rectangle,** $A = l \times b$

DIFFERENTIATION

1. Differentiate the following w.r.t. x by the method of first principal

   1. x^n 2. $\sin x$ 3. $\cos x$ 4. $\tan x$

2. Differentiate the following

1. x^{-100}	2. $\sqrt{x}$	3. e^{2x}	4. x^{29}
$\tan x$	$\log x$	5^x	9^x
100^x	x^n	$x^n + \frac{1}{x^n}$	$\cos ecx$
$\sec x$	$\frac{1}{x}$	$\cos ax$	$\tan ax$
x^3	x^2	x	1
5	100	3	9
$2x$	$5x$	$6x$	$7x$
$-x$	$-2x$	$-4x$	$-\log x$
e^{-2x}	e^{-9x}	e^{-x}	e^{-3x}
$\sin ax$	$\tan 3x$	$\cos 4x$	$\tan 6x$
$\sec 4x$	$-\tan x$	$-\sin x$	$-\cos x$
x^{-n}	$5\sin x$	$4e^{-2x}$	$5x^2$
$6x^3$	$9x$	9	$5\log x$
$\tan 6x$	$\sin 4x$	$\tan 10x$	$\cos ec4x$
0	$-2x$	$-\frac{1}{x}$	$-x$

3. Differentiate the following

$\sqrt{x} + \log x + \sin^{-1} x + e^{\tan x} - a^x$

$6x^3 - 3\cos x + 4\cot x + 2e^x - \frac{5}{x}$

$x^3 + \sec x - \log x + e^{-3x} - \sqrt{x}$

$ax^3 + bx^2 + cx + d\frac{1}{x} - \cos ecx$

$\log x + x^4 + \sec x - \cos ex - e^{-2x}$

$\tan x + x^5 + \log x + 5x + 9$

$\tan x + x^7 + e^{\tan x} + \log x + 5$

4. PRODUCT RULE

$x\tan x$	$x^3 \log x$	$e^x \sin x$	xe^x
$x^3 \sin x$	$\cot x.9^x$	$x^3 3^x$	$4x\cos ecx$
$\sqrt{x}\tan x$	$e^{3x}\sqrt{x}$	$4^x e^{2x}$	$x^{-4}\sec 9x$

5. QUOTIENT RULE

$\frac{\cos x}{x}$	$\frac{\tan x}{x}$	$\frac{a\sin x + b}{a + b\cos x}$
$\frac{x^3 + x - 3}{x^2 - 5x + 1}$	$\frac{\cos x}{2 + \sin x}$	$\frac{x\log x}{x - 1}$
$\frac{1 - \sin x}{1 + \sin x}$	$\frac{\cos x + \sin x}{\cos x - \sin x}$	$\frac{1 - e^x}{1 + e^x}$
$\frac{x + 3}{x^2 - 1}$	$\frac{\sin x}{1 + \cos x}$	$\frac{1 + x + x^2}{1 - x + x^2}$

6. CHAIN RULE

$\sqrt{x^2 + 4x + 6}$	$\cos ax$	$\cos^2(3x - 7)$
$\log(\sec x + \tan x)$	$\log\sqrt{\sin(\sqrt{x})}$	$\sqrt{\cos x}$
$\sqrt{\frac{1 - \cos x}{1 + \cos x}}$	$\sqrt{1 + \cos^2 x}$	$\sin^3 x$
$\sqrt{x\cos x}$	$(x+1)^2 \tan\sqrt{x}$	$e^{\sin^{-1} x}$

7. IMPLICIT FUNCTIONS

$y^2,\quad y^3,\quad y^5,\quad y$

$x^2 + y^2 = a^2$

$y = x^2 + \sqrt{y} + xy$

$2x^2 - 3xy + 4y^2 = 1$

$x^2 + y^2 + 2x + 2y = 2xy$

$\log x + \log y = x^3 + y^3$

$x^2(x - y) = 4$

$x^3 = 1 + \sqrt{y}$

$x^3 + y^3 = 3axy$

If $x^2 + xy + y^2 = 0$ *evaluate* $\frac{dy}{dx}$ *at* $x = 1, y = 2$

$ax^2 + 2hxy + by^2 + 8 = 0$

$x^2 + xy + y^2 = 0$

$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$

$\sqrt{x} + 2xy + \sqrt{y} + 4 = 0$

if $x^2 + y^2 = xy$ *then prove that* $\frac{dy}{dx} = \frac{y - 2x}{2x - y}$

8. PARAMETRIC FUNCTION

$x = a\theta^2$	$y = 2a\theta$
$x = a\cos^3\theta$	$y = b\sin^3\theta$
$x = a\cos\theta$	$y = a\sin\theta$
$x = a(\cos\theta + a\sin\theta)$	$y = a(\sin\theta - \theta\cos\theta)$
$x = 2\sin\theta$	$y = \cos 2\theta$ *at* $\theta = \frac{\pi}{4}$
$x = a\cos^4 t$	$y = b\sin^4 t$
$x = a\cos\theta$	$y = b\sin\theta$ *at* $\theta = \frac{\pi}{4}$

9. LOGARITHMIC FUNCTION

$y = x^x, y = x^{\frac{1}{x}}, y = \sin x^{\cos x}, y = \tan x^{\cos x}$

$y = \log x^{\log x}, y = x^{\log x}, \quad y = \cos x^{\sin x}$

10. Differentiation of a function w.r.t. another function

Differentiate sinx w.r.t. cosx

Differentiate x^3 w.r.t. $\tan^{-1} x$

Differentiate cosx w.r.t. e^x

Differentiate $e^{\sqrt{\sin x}}$ w.r.t. x^2

11. Successive differentiation

Find the second order derivative of the following functions

$(ax+b)^7$

$\log(ax+b)$

ax^3+bx^2+cx+d

$\sin^2 x$

1. *If* $y = xe^x$ *find* $\frac{d^2y}{dx^2}$ *at* $x=0$
2. *if* $y = ae^{mx} + be^{-mx}$ *then prove that* $\frac{d^2y}{dx^2} - m^2y = 0$
3. *If* $y = (\tan^{-1}x)^2$ *then prove that* $(1+x^2)^2 y_2 + 2x(1+x^2)y_1 - 2 = 0$
4. *If* $y = \tan^{-1}x$ *prove that* $(1+x^2)y_2 - 12xy_1 = 0$
5. *If* $y = e^{\tan^{-1}x}$ *TPT* $(1+x^2)y_2 + (2x-1)y_1 = 0$
6. *If* $y = \tan^{-1}x$ *TPT* $(1+x^2)y_2 + 2xy_1 = 0$
7. *if* $y = e^{3x}$ *find* $\frac{d^2y}{dx^2}$ *at* $x=0$
8. *If* $y = e^x \sin x$ *find* $\frac{d^2y}{dx^2}$

APPLICATION OF DERIVATIVES

1.Find the equation of tangent to the curve $x^2+2y^2=4$ at (2, -1) on it.

2. Find the equation of tangent to the curve $y = 3x^2 - 6x$ at (2, 1) on it.

3. Find the equation of tangent to the curve $y = x^2 + x + 4$ at the point where it crosses y-axis

4. Find the equation of tangent and normal to the curve $y = x^3 + 4x^2 - 6x + 5$ at (1, -4) on it.

1. Find the points on the curve $y = 2x^3 - 3x^2 + 5$ where tangent is parallel to x- axis
2. Find the equation of tangent and normal to the curve $y(x^2+1) = x+3$ at (2,1) on it.
3. Find the equation of normal to the curve $y^2 = 16x$ at $(\frac{1}{2}, 1)$ on it.
4. Find the slope tangent to the curve $x^2+2y^2=9$ at (1, 2) on it.
5. find the slope of the normal to the curve $y = 2x^2 + x + 6$ at (1, -1) on it.
6. find the slope of the tangent to the curve $y = 2x^2 + 1$ at (0,1) on it.
7. Find the slope tangent to the curve $y = 2x^2 + 4x - 3$ at (2,3) on it.
8. Find the slope tangent to the curve $3x^2+2y^2=5$ at (1,1) on it.
9. Find the slope tangent to the curve $y = 2x^2 - 3x - 1$ at (1,-2) on it.

DERIVATIVE AS A RATE MEASURE

1. The equation of motion is given by $s = 2t^2 - 3t + 1$.find the velocity aftr 3 sec
2. The equation of motion is given by $s = (2t+1)^2$ .find the velocity and acceleration
3. The equation of motion is given by $s = t^3 + t^2 - 3t + 6$ .find the velocity and acceleration aftr 2 sec
4. The equation of motion is given by $s = 4t^3 - 6t^2 + t - 7$ .find the velocity aftr 2 sec
5. The equation of motion is given by $s = t^3 + 3t + 5$ .find the velocity aftr 3 sec
6. The equation of motion is given by $S = 4t^3 - 6t^2 + t - 7$ .find the velocity aftr 2 sec
7. The equation of motion is given by $s = 4t^3 - 6t^2 + t - 7$ .find the velocity and acceleration after 2 sec
8. A ball is thrown vertically upwards and reaches maximum height S in metre.the height reached is given by S=-16t^2+64t. how much time is taken reach maximum height?
9. Distance travelled by a car is given by S=160t-16t^2 metre and time in sec.when does the car stop?
10. The circular patch of oil spreads on water he area increasing at the rate 16cm^2/sec. find the rate of increasing of radius when the radius is 12cm
11. The volume of spherical ball in increasing at the rate of 36πcc/sec. Find the rate at which the radius is increasing when the radius of the ball is 2cm.
12. The volume of sphere is increasing at the rate of 2cc/sec. Find the rate at which the radius is increasing when the radius of the ball is 15cm.
13. If the volume of balloon which is being inflated at the rate of 6cc/min. Find the rate at which its surface area is increasing when the radius of balloon is 12cms.
14. The radius of a spherical balloon is increasing at the rate of 2cm/s., Find the rate of increase of volume when the radius is 6sm.
15. Water is flowing into a right circular cylindrical tank of radius 50cms At the rate of 500cc/min.find how fast is the level of water going up
16. Show that the curve 2x^3-y=0 is increasing at the point(1,2)
17. Find maximum and minimum values of the function x^3-6x^2+9x+7
18. Find maximum and minimum values of the function x^3+6x^2-15x+5
19. Find maximum and minimum values of the function x^3+6x^2+9x
20. Find maximum and minimum values of the function x^3-3x+4