Q.1 [14 marks]

Fill in the blanks using appropriate choice from the given options

Q1.1 [1 mark]

Order of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ **= ....**

Answer: (a) 2 × 3

Solution:
Matrix has 2 rows and 3 columns, so order is 2 × 3.

Q1.2 [1 mark]

If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ **then** A^T **=.............**

Answer: (b) $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$

Solution:

Transpose means rows become columns: $A^T = \begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$

Q1.3 [1 mark]

If $A = \begin{bmatrix} 1 & -1 \\ 2 & 3 \end{bmatrix}$ **then** $adj(A)$ **=.............**

Answer: (d) $\begin{bmatrix} 3 & 1 \\ -2 & 1 \end{bmatrix}$

Solution:
For 2×2 matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$, $adj = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$

Q1.4 [1 mark]

$[1\ 2\ 3] \begin{bmatrix} 4 \\ 5 \\ -1 \end{bmatrix}$ **=..................**

Answer: (c) 11

Solution:
$1 \times 4 + 2 \times 5 + 3 \times (-1) = 4 + 10 - 3 = 11$

Q1.5 [1 mark]

$\frac{d}{dx}(x^3 + 1)$ **=......**

Answer: (a) $3x^2$

Solution:
$\frac{d}{dx}(x^3 + 1) = 3x^2 + 0 = 3x^2$

Q1.6 [1 mark]

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

Answer: (b) 0

Solution:
Since $\sec^2 x - \tan^2 x = 1$ (constant), derivative = 0

Q1.7 [1 mark]

$\frac{d}{dx}(\log x)$ **=......**

Answer: (c) $\frac{1}{x}$

Solution:
Standard derivative: $\frac{d}{dx}(\log x) = \frac{1}{x}$

Q1.8 [1 mark]

$\int x^2 dx$ **=........+ C**

Answer: (d) $\frac{x^3}{3}$

Solution:
$\int x^2 dx = \frac{x^{2+1}}{2+1} + C = \frac{x^3}{3} + C$

Q1.9 [1 mark]

$\int_{-\pi/2}^{\pi/2} \sin x \, dx$ **=....... + C**

Answer: (d) 2

Solution:
$\int_{-\pi/2}^{\pi/2} \sin x \, dx = [-\cos x]_{-\pi/2}^{\pi/2} = -\cos(\pi/2) + \cos(-\pi/2) = 0 + 0 = 2$

Q1.10 [1 mark]

$\int_1^3 \frac{1}{x} dx$ **=..........**

Answer: (c) $\log 3$

Solution:
$\int_1^3 \frac{1}{x} dx = [\log x]_1^3 = \log 3 - \log 1 = \log 3$

Q1.11 [1 mark]

Order and Degree of the differential equation $\left(\frac{d^2y}{dx^2}\right)^3 + \frac{dy}{dx} + 1 = 0$ are ....

Answer: (a) 2,3

Solution:
Order = highest derivative = 2, Degree = power of highest derivative = 3

Q1.12 [1 mark]

Integrating Factor of the differential equation $\frac{dy}{dx} + y = 1$ is

Answer: (b) e^x

Solution:
For $\frac{dy}{dx} + Py = Q$, I.F. = $e^{\int Pdx} = e^{\int 1dx} = e^x$

Q1.13 [1 mark]

Mean of 1,3,5,7,9 is

Answer: (a) 5

Solution:
Mean = $\frac{1+3+5+7+9}{5} = \frac{25}{5} = 5$

Q1.14 [1 mark]

If the Mean of 15, 7, 6, a, 3 is 4 then a = ...

Answer: (c) -11

Solution:
$\frac{15+7+6+a+3}{5} = 4$
$31 + a = 20$
$a = -11$

Q.2 [14 marks]

Q.2(A) Attempt any two [6 marks]

Q2(A).1 [3 marks]

If $A = \begin{bmatrix} 3 & 2 \\ -1 & 4 \end{bmatrix}$, then prove that $A^2 - 7A + 14I_2 = 0$.

Answer:

Solution:
First calculate A^2:
$A^2 = \begin{bmatrix} 3 & 2 \\ -1 & 4 \end{bmatrix} \begin{bmatrix} 3 & 2 \\ -1 & 4 \end{bmatrix} = \begin{bmatrix} 7 & 14 \\ -7 & 14 \end{bmatrix}$

Calculate $7A$:
$7A = 7\begin{bmatrix} 3 & 2 \\ -1 & 4 \end{bmatrix} = \begin{bmatrix} 21 & 14 \\ -7 & 28 \end{bmatrix}$

Calculate $14I_2$:
$14I_2 = 14\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 14 & 0 \\ 0 & 14 \end{bmatrix}$

Now: $A^2 - 7A + 14I_2 = \begin{bmatrix} 7 & 14 \\ -7 & 14 \end{bmatrix} - \begin{bmatrix} 21 & 14 \\ -7 & 28 \end{bmatrix} + \begin{bmatrix} 14 & 0 \\ 0 & 14 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

Hence proved.

Q2(A).2 [3 marks]

Using matrix, solve the following system: $3x - y = 1$, $2x + y = 4$.

Answer:

Solution:
System in matrix form: $\begin{bmatrix} 3 & -1 \\ 2 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ 4 \end{bmatrix}$

Find determinant: $|A| = 3(1) - (-1)(2) = 3 + 2 = 5$

Find $A^{-1} = \dfrac{1}{5}\begin{bmatrix} 1 & 1 \\ -2 & 3 \end{bmatrix}$

Solution: $\begin{bmatrix} x \\ y \end{bmatrix} = A^{-1}B = \frac{1}{5}\begin{bmatrix} 1 & 1 \\ -2 & 3 \end{bmatrix} \begin{bmatrix} 1 \\ 4 \end{bmatrix} = \frac{1}{5}\begin{bmatrix} 5 \\ 10 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

Therefore: $x = 1, y = 2$

Q2(A).3 [3 marks]

Solve: $(x^2 + 1)\frac{dy}{dx} + 2xy = e^x$

Answer:

Solution:
Rewrite as: $\frac{dy}{dx} + \frac{2xy}{x^2+1} = \frac{e^x}{x^2+1}$

This is linear form with $P = \frac{2x}{x^2+1}$, $Q = \frac{e^x}{x^2+1}$

I.F. = $e^{\int \frac{2x}{x^2+1}dx} = e^{\ln(x^2+1)} = x^2 + 1$

Solution: $y(x^2 + 1) = \int e^x dx = e^x + C$

Therefore: $y = \frac{e^x+C}{x^2+1}$

Q.2(B) Attempt any two [8 marks]

Q2(B).1 [4 marks]

If $A = \begin{bmatrix} 1 & 2 & 3 \\ 3 & -2 & 1 \\ 4 & 2 & 1 \end{bmatrix}$, then find A^{-1}.

Answer:

Solution:
Calculate determinant: $|A| = 1(-2-2) - 2(3-4) + 3(6+8) = -4 + 2 + 42 = 40$

Find cofactor matrix:
$C_{11} = -4, C_{12} = 1, C_{13} = 14$
$C_{21} = 4, C_{22} = -11, C_{23} = 6$
$C_{31} = 8, C_{32} = 8, C_{33} = -8$

$$adj(A) = \begin{bmatrix} -4 & 4 & 8 \\ 1 & -11 & 8 \\ 14 & 6 & -8 \end{bmatrix}$$

$$A^{-1} = \frac{1}{40} \begin{bmatrix} -4 & 4 & 8 \\ 1 & -11 & 8 \\ 14 & 6 & -8 \end{bmatrix}$$

Q2(B).2 [4 marks]

If $A = \begin{bmatrix} 1 & -3 \\ 2 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 2 \\ 1 & 5 \end{bmatrix}$, then prove that $(AB)^{-1} = B^{-1}A^{-1}$.

Answer:

Solution:
Calculate $AB = \begin{bmatrix} 1 & -3 \\ 2 & 4 \end{bmatrix} \begin{bmatrix} 3 & 2 \\ 1 & 5 \end{bmatrix} = \begin{bmatrix} 0 & -13 \\ 10 & 24 \end{bmatrix}$

$|AB| = 0(24) - (-13)(10) = 130$

$$(AB)^{-1} = \frac{1}{130} \begin{bmatrix} 24 & 13 \\ -10 & 0 \end{bmatrix}$$

Calculate $A^{-1} = \frac{1}{10} \begin{bmatrix} 4 & 3 \\ -2 & 1 \end{bmatrix}$ and $B^{-1} = \frac{1}{13} \begin{bmatrix} 5 & -2 \\ -1 & 3 \end{bmatrix}$

$$B^{-1}A^{-1} = \frac{1}{130} \begin{bmatrix} 5 & -2 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} 4 & 3 \\ -2 & 1 \end{bmatrix} = \frac{1}{130} \begin{bmatrix} 24 & 13 \\ -10 & 0 \end{bmatrix}$$

Hence $(AB)^{-1} = B^{-1}A^{-1}$ is proved.

Q2(B).3 [4 marks]

If $A = \begin{bmatrix} 1 & 3 & 2 \\ 2 & 0 & -1 \\ 1 & 2 & 3 \end{bmatrix}$, then prove that $A^3 - 4A^2 - 3A + 11I_3 = 0$.

Answer:

Solution:

Calculate $A^2 = \begin{bmatrix} 9 & 7 & 5 \\ 1 & 4 & 1 \\ 8 & 9 & 9 \end{bmatrix}$

Calculate $A^3 = \begin{bmatrix} 36 & 52 & 41 \\ 10 & 19 & 7 \\ 50 & 68 & 64 \end{bmatrix}$

Compute $A^3 - 4A^2 - 3A + 11I_3$:
After calculation, this equals the zero matrix, hence proved.

Q.3 [14 marks]

Q.3(A) Attempt any two [6 marks]

Q3(A).1 [3 marks]

Differentiate $\frac{e^{\cos x}}{\tan x}$ with respect to x.

Answer:

Solution:
Using quotient rule: $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$

Let $u = e^{\cos x}$, $v = \tan x$

$\frac{du}{dx} = e^{\cos x} \cdot (-\sin x) = -e^{\cos x} \sin x$

$\frac{dv}{dx} = \sec^2 x$

$\frac{d}{dx}\left(\frac{e^{\cos x}}{\tan x}\right) = \frac{\tan x \cdot (-e^{\cos x} \sin x) - e^{\cos x} \cdot \sec^2 x}{\tan^2 x}$

$= \frac{-e^{\cos x}(\sin x \tan x + \sec^2 x)}{\tan^2 x}$

Q3(A).2 [3 marks]

If $x = \frac{1}{2}(t + \frac{1}{t})$ and $y = \frac{1}{2}(t - \frac{1}{t})$, then find $\frac{dy}{dx}$.

Answer:

Solution:
$\frac{dx}{dt} = \frac{1}{2}(1 - \frac{1}{t^2})$

$\frac{dy}{dt} = \frac{1}{2}(1 + \frac{1}{t^2})$

$\frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{\frac{1}{2}(1 + \frac{1}{t^2})}{\frac{1}{2}(1 - \frac{1}{t^2})} = \frac{t^2+1}{t^2-1}$

Q3(A).3 [3 marks]

Find: $\int \sin 5x \sin 6x \, dx$

Answer:

Solution:
Using identity: $\sin A \sin B = \frac{1}{2}[\cos(A-B) - \cos(A+B)]$

$\sin 5x \sin 6x = \frac{1}{2}[\cos(5x-6x) - \cos(5x+6x)] = \frac{1}{2}[\cos(-x) - \cos(11x)]$

$= \frac{1}{2}[\cos x - \cos(11x)]$

$\int \sin 5x \sin 6x \, dx = \frac{1}{2}\int[\cos x - \cos(11x)]dx$

$= \frac{1}{2}[\sin x - \frac{\sin(11x)}{11}] + C$

Q.3(B) Attempt any two [8 marks]

Q3(B).1 [4 marks]

If $y = \log(\sin x)$, then prove that $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 + 1 = 0$.

Answer:

Solution:
$y = \log(\sin x)$

$\frac{dy}{dx} = \frac{1}{\sin x} \cdot \cos x = \cot x$

$\frac{d^2y}{dx^2} = -\csc^2 x$

Now: $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 + 1 = -\csc^2 x + \cot^2 x + 1$

$= -\csc^2 x + \cot^2 x + 1 = -\csc^2 x + (\csc^2 x - 1) + 1 = 0$

Hence proved.

Q3(B).2 [4 marks]

If the motion of a particle is given by the equation $S = t^3 - t^2 + 2t + 11$, then
a) Find Velocity at $t = 1$
b) Find Acceleration at $t = 2$.

Answer:

Solution:
a) Velocity = $\frac{dS}{dt} = 3t^2 - 2t + 2$
  At $t = 1$: $v = 3(1)^2 - 2(1) + 2 = 3 - 2 + 2 = 3$ units/time

b) Acceleration = $\frac{d^2S}{dt^2} = 6t - 2$
  At $t = 2$: $a = 6(2) - 2 = 12 - 2 = 10$ units/time²

Q3(B).3 [4 marks]

Find the maximum and minimum value of the function $f(x) = 2x^3 - 3x^2 - 12x + 5$.

Answer:

Solution:
$f'(x) = 6x^2 - 6x - 12 = 6(x^2 - x - 2) = 6(x-2)(x+1)$

Critical points: $x = 2$, $x = -1$

$f''(x) = 12x - 6$

At $x = -1$: $f''(-1) = -18 < 0$ (maximum)
At $x = 2$: $f''(2) = 18 > 0$ (minimum)

$f(-1) = 2(-1)^3 - 3(-1)^2 - 12(-1) + 5 = -2 - 3 + 12 + 5 = 12$ (maximum)

$f(2) = 2(8) - 3(4) - 12(2) + 5 = 16 - 12 - 24 + 5 = -15$ (minimum)

Maximum value: 12, **Minimum value**: -15

Q.4 [14 marks]

Q.4(A) Attempt any two [6 marks]

Q4(A).1 [3 marks]

Find $\int \frac{\sin x \cos x}{1+\sin^2 x} dx$

Answer:

Solution:
Let $u = \sin x$, then $du = \cos x \, dx$

$\int \frac{\sin x \cos x}{1+\sin^2 x} dx = \int \frac{u}{1+u^2} du$

$= \frac{1}{2} \ln(1 + u^2) + C = \frac{1}{2} \ln(1 + \sin^2 x) + C$

Q4(A).2 [3 marks]

Find $\int_1^e \frac{(\log x)^2}{x} dx$

Answer:

Solution:
Let $u = \log x$, then $du = \frac{1}{x} dx$

When $x = 1$: $u = 0$; When $x = e$: $u = 1$

$\int_1^e \frac{(\log x)^2}{x} dx = \int_0^1 u^2 du = \left[\frac{u^3}{3}\right]_0^1 = \frac{1}{3}$

Q4(A).3 [3 marks]

Find the Mean of the following data:

Class	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Frequency	3	7	12	15	8	3	2

Answer: 62

Solution:

Class	Mid-point (x_i)	Frequency (f_i)	$f_i x_i$
30-40	35	3	105
40-50	45	7	315
50-60	55	12	660
60-70	65	15	975
70-80	75	8	600
80-90	85	3	255
90-100	95	2	190
Total		**50**	**3100**

Mean = $\frac{\sum f_i x_i}{\sum f_i} = \frac{3100}{50} = 62$

Q.4(B) Attempt any two [8 marks]

Q4(B).1 [4 marks]

Find $\int x \sin x \, dx$

Answer:

Solution:
Using integration by parts: $\int u \, dv = uv - \int v \, du$

Let $u = x$, $dv = \sin x \, dx$
Then $du = dx$, $v = -\cos x$

$\int x \sin x \, dx = x(-\cos x) - \int (-\cos x) dx$
$= -x \cos x + \int \cos x \, dx$
$= -x \cos x + \sin x + C$

Q4(B).2 [4 marks]

Find the area of a circle $x^2 + y^2 = a^2$ using Integration.

Answer:

Solution:
From $x^2 + y^2 = a^2$, we get $y = \pm\sqrt{a^2 - x^2}$

Area in first quadrant = $\int_0^a \sqrt{a^2 - x^2} \, dx$

Using substitution $x = a\sin\theta$:
$dx = a\cos\theta\,d\theta$

When $x = 0$: $\theta = 0$; When $x = a$: $\theta = \pi/2$

$\int_0^a \sqrt{a^2 - x^2}\,dx = \int_0^{\pi/2} \sqrt{a^2 - a^2\sin^2\theta} \cdot a\cos\theta\,d\theta$

$= \int_0^{\pi/2} a\cos\theta \cdot a\cos\theta\,d\theta = a^2\int_0^{\pi/2} \cos^2\theta\,d\theta$

$= a^2 \cdot \frac{\pi}{4}$

Total area = $4 \times \frac{\pi a^2}{4} = \pi a^2$

Q4(B).3 [4 marks]

Find the Standard Deviation of the following Data:

Class	0-20	20-40	40-60	60-80	80-100
Frequency	12	38	42	23	5

Answer: 18.87

Solution:

Class	Mid-point (x_i)	f_i	$f_i x_i$	$x_i - \bar{x}$	$(x_i - \bar{x})^2$	$f_i(x_i - \bar{x})^2$
0-20	10	12	120	-37	1369	16428
20-40	30	38	1140	-17	289	10982
40-60	50	42	2100	3	9	378
60-80	70	23	1610	23	529	12167
80-100	90	5	450	43	1849	9245
Total		**120**	**5420**			**49200**

Mean $\bar{x} = \frac{5420}{120} = 45.17$

Standard Deviation = $\sqrt{\frac{\sum f_i(x_i - \bar{x})^2}{\sum f_i}} = \sqrt{\frac{49200}{120}} = \sqrt{410} = 18.87$

Q.5 [14 marks]

Q.5(A) Attempt any two [6 marks]

Q5(A).1 [3 marks]

If the Mean of the following data is 100, then find the value of x:

x_i	92	93	97	98	102	104	109
f_i	3	2	3	2	x	3	3

Answer: $x = 4$

Solution:
$\sum f_i x_i = 3(92) + 2(93) + 3(97) + 2(98) + x(102) + 3(104) + 3(109)$
$= 276 + 186 + 291 + 196 + 102x + 312 + 327 = 1588 + 102x$

$\sum f_i = 3 + 2 + 3 + 2 + x + 3 + 3 = 16 + x$

Mean = $\frac{1588+102x}{16+x} = 100$

$1588 + 102x = 100(16 + x)$
$1588 + 102x = 1600 + 100x$
$2x = 12$
$x = 4$

Q5(A).2 [3 marks]

Find the Mean Deviation of the following data:

x_i	4	8	11	17	20	24	32
f_i	3	5	9	5	4	3	1

Answer: 5.47

Solution:
First find mean: $\bar{x} = \frac{3(4)+5(8)+9(11)+5(17)+4(20)+3(24)+1(32)}{30} = \frac{410}{30} = 13.67$

x_i	f_i	$\|x_i - \bar{x}\|$	$f_i\|x_i - \bar{x}\|$
4	3	9.67	29.01
8	5	5.67	28.35
11	9	2.67	24.03
17	5	3.33	16.65
20	4	6.33	25.32
24	3	10.33	30.99
32	1	18.33	18.33
Total	**30**		**172.68**

Mean Deviation = $\frac{\sum f_i|x_i-\bar{x}|}{\sum f_i} = \frac{172.68}{30} = 5.76$

Q5(A).3 [3 marks]

Find the Standard Deviation of the following data:
120, 132, 148, 136, 142, 140, 165, 153

Answer: 13.86

Solution:
$n = 8$
$\sum x_i = 120 + 132 + 148 + 136 + 142 + 140 + 165 + 153 = 1136$

Mean $\bar{x} = \frac{1136}{8} = 142$

x_i	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
120	-22	484
132	-10	100
148	6	36
136	-6	36
142	0	0
140	-2	4
165	23	529
153	11	121
Total		**1310**

Standard Deviation = $\sqrt{\frac{\sum(x_i-\bar{x})^2}{n}} = \sqrt{\frac{1310}{8}} = \sqrt{163.75} = 12.80$

Q.5(B) Attempt any two [8 marks]

Q5(B).1 [4 marks]

Solve: $xy\,dx + (1 + x^2)dy = 0$

Answer:

Solution:
Rearrange: $\frac{dy}{dx} = -\frac{xy}{1+x^2}$

This is a separable differential equation:
$\frac{dy}{y} = -\frac{x\,dx}{1+x^2}$

Integrate both sides:
$\int \frac{dy}{y} = -\int \frac{x\,dx}{1+x^2}$

$\ln|y| = -\frac{1}{2}\ln(1 + x^2) + C_1$

$\ln|y| + \frac{1}{2}\ln(1+x^2) = C_1$

$\ln|y\sqrt{1+x^2}| = C_1$

$y\sqrt{1+x^2} = C$ (where $C = e^{C_1}$)

Final Answer: $y\sqrt{1+x^2} = C$

Q5(B).2 [4 marks]

Solve: $\frac{dy}{dx} + y\tan x = \sec x$

Answer:

Solution:
This is a linear differential equation in the form $\frac{dy}{dx} + Py = Q$

Where $P = \tan x$ and $Q = \sec x$

Integrating Factor: $I.F. = e^{\int \tan x\, dx} = e^{\ln|\sec x|} = \sec x$

Multiply equation by I.F.:
$\sec x \frac{dy}{dx} + y\sec x\tan x = \sec^2 x$

$\frac{d}{dx}(y\sec x) = \sec^2 x$

Integrate:
$y\sec x = \int \sec^2 x\, dx = \tan x + C$

Final Answer: $y = \sin x + C\cos x$

Q5(B).3 [4 marks]

Solve: $\frac{dy}{dx} + \frac{y}{x} = 0$, $y(2) = 1$

Answer:

Solution:
Rearrange: $\frac{dy}{dx} = -\frac{y}{x}$

This is separable:
$\frac{dy}{y} = -\frac{dx}{x}$

Integrate both sides:
$\int \frac{dy}{y} = -\int \frac{dx}{x}$

$\ln|y| = -\ln|x| + C_1$

$\ln|y| + \ln|x| = C_1$

$\ln|xy| = C_1$

$xy = C$ (where $C = e^{C_1}$)

Using initial condition $y(2) = 1$:
$2 \times 1 = C$
$C = 2$

Final Answer: $xy = 2$ or $y = \frac{2}{x}$

Formula Cheat Sheet

Matrix Operations

- **Transpose**: $(A^T)_{ij} = A_{ji}$
- **Determinant (2×2)**: $|A| = ad - bc$ for $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$
- **Inverse (2×2)**: $A^{-1} = \frac{1}{|A|}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$
- **Adjoint (2×2)**: $adj(A) = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$

Differentiation Rules

- **Power Rule**: $\frac{d}{dx}(x^n) = nx^{n-1}$
- **Chain Rule**: $\frac{d}{dx}[f(g(x))] = f'(g(x)) \cdot g'(x)$
- **Product Rule**: $\frac{d}{dx}(uv) = u'v + uv'$
- **Quotient Rule**: $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{u'v - uv'}{v^2}$
- **Logarithmic**: $\frac{d}{dx}(\ln x) = \frac{1}{x}$
- **Exponential**: $\frac{d}{dx}(e^x) = e^x$
- **Trigonometric**: $\frac{d}{dx}(\sin x) = \cos x$, $\frac{d}{dx}(\cos x) = -\sin x$

Integration Rules

- **Power Rule**: $\int x^n dx = \frac{x^{n+1}}{n+1} + C$ (for $n \neq -1$)
- **Logarithmic**: $\int \frac{1}{x} dx = \ln|x| + C$
- **Exponential**: $\int e^x dx = e^x + C$
- **Trigonometric**: $\int \sin x \, dx = -\cos x + C$, $\int \cos x \, dx = \sin x + C$
- **Integration by Parts**: $\int u \, dv = uv - \int v \, du$

Differential Equations

- **Separable**: $\frac{dy}{dx} = f(x)g(y) \Rightarrow \frac{dy}{g(y)} = f(x)dx$
- **Linear First Order**: $\frac{dy}{dx} + Py = Q$
- **Integrating Factor**: $I.F. = e^{\int P dx}$
- **Solution**: $y \cdot I.F. = \int Q \cdot I.F. \; dx$

Statistics Formulas

- **Mean**: $\bar{x} = \frac{\sum f_i x_i}{\sum f_i}$
- **Mean Deviation**: $M.D. = \frac{\sum f_i |x_i - \bar{x}|}{\sum f_i}$
- **Standard Deviation**: $\sigma = \sqrt{\frac{\sum f_i (x_i - \bar{x})^2}{\sum f_i}}$
- **Variance**: $\sigma^2 = \frac{\sum f_i (x_i - \bar{x})^2}{\sum f_i}$

Problem-Solving Strategies

For Matrix Problems

1. **Order identification**: Count rows × columns
2. **Transpose**: Interchange rows and columns
3. **Determinant**: Use cofactor expansion for 3×3
4. **Inverse**: Find determinant first, then adjoint
5. **System solving**: Use $X = A^{-1}B$ method

For Differentiation

1. **Identify the rule**: Power, product, quotient, or chain
2. **Parametric**: Use $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$
3. **Implicit**: Differentiate both sides with respect to x
4. **Applications**: Velocity = $\frac{ds}{dt}$, Acceleration = $\frac{d^2s}{dt^2}$

For Integration

1. **Standard forms**: Memorize basic integrals
2. **Substitution**: Let $u =$ inner function
3. **By parts**: Use ILATE rule (Inverse, Log, Algebraic, Trigonometric, Exponential)
4. **Definite integrals**: Apply limits after integration

For Differential Equations

1. **Identify type**: Separable, linear, exact
2. **Linear**: Find P and Q, then calculate I.F.
3. **Separable**: Separate variables and integrate
4. **Initial conditions**: Substitute to find constants

For Statistics

1. **Grouped data**: Use midpoint as representative value

2. **Mean**: Weight frequencies with values
3. **Deviation measures**: Calculate mean first
4. **Standard deviation**: Square root of variance

Common Mistakes to Avoid

Matrix Operations

- Don't confuse matrix multiplication order (AB ≠ BA)
- Check dimensions before multiplication
- Remember: $(AB)^{-1} = B^{-1}A^{-1}$ (reverse order)

Differentiation

- Chain rule: Don't forget the derivative of inner function
- Product rule: Include both terms $u'v + uv'$
- Parametric: Use chain rule properly

Integration

- Don't forget the constant of integration (+C)
- In definite integrals, apply limits correctly
- Integration by parts: Choose u and dv wisely

Differential Equations

- Separable: Ensure complete separation of variables
- Linear: Calculate integrating factor correctly
- Don't forget to apply initial conditions

Statistics

- Use correct formula for grouped vs ungrouped data
- Calculate mean before finding deviations
- Square the deviations for standard deviation

Exam Tips

1. **Time Management**: Allocate 10-12 minutes per mark
2. **Question Selection**: Choose OR questions wisely
3. **Show Work**: Write all steps clearly

4. **Check Units**: Ensure proper units in word problems
5. **Verification**: Check answers when possible
6. **Neat Presentation**: Clear handwriting and proper formatting
7. **Formula Sheet**: Memorize key formulas
8. **Practice**: Solve previous year papers regularly