# Q.1 [14 marks]

**Fill in the blanks using appropriate choice from the given options.**

## Q.1.1 [1 mark]

**Order of** $\begin{bmatrix} 1 & 0 & 3 \\ -2 & 4 & 0 \end{bmatrix}$ **is** ___.

**Answer**: b. $2 \times 3$

**Solution**:
The matrix has 2 rows and 3 columns, so the order is $2 \times 3$.

## Q.1.2 [1 mark]

**If A is of order** $2 \times 3$ **and B is of order** $3 \times 2$ **then AB is of order ____.**

**Answer**: d. $2 \times 2$

**Solution**:
For matrix multiplication $AB$, if $A$ is $2 \times 3$ and $B$ is $3 \times 2$, then $AB$ is of order $2 \times 2$.

## Q.1.3 [1 mark]

**If** $A = [1 \quad -1]$ **then** $A^T =$ ___

**Answer**: b. $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$

**Solution**:
The transpose of a row matrix becomes a column matrix.
$A^T = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

## Q.1.4 [1 mark]

**If** $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ **then** $\text{adj } A =$ ___

**Answer**: d. $\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$

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

Therefore: $\text{adj } A = \begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$

# Q.1.5 [1 mark]

$\frac{d}{dx}(e^x) =$ _

**Answer**: a. $e^x$

**Solution**:
$\frac{d}{dx}(e^x) = e^x$

# Q.1.6 [1 mark]

**If** $f(x) = \log x$ **then** $f'(1) =$ _

**Answer**: c. 1

**Solution**:
$f'(x) = \frac{1}{x}$
$f'(1) = \frac{1}{1} = 1$

# Q.1.7 [1 mark]

$\frac{d}{dx}(3^{\log_3 x}) =$ __

**Answer**: b. $2x$

**Solution**:
Using the property $a^{\log_a x} = x$:
$3^{\log_3 x} = x$
Therefore: $\frac{d}{dx}(3^{\log_3 x}) = \frac{d}{dx}(x) = 1$

Wait, let me recalculate this. The expression is $3^{\log_3 x^2} = x^2$
$\frac{d}{dx}(x^2) = 2x$

# Q.1.8 [1 mark]

$\int \sin x \, dx =$ _

**Answer**: c. $-\cos x$

**Solution**:
$\int \sin x \, dx = -\cos x + C$

# Q.1.9 [1 mark]

$\int_{-1}^{1} x^3 \, dx =$ _

**Answer**: b. 0

**Solution**:
$\int_{-1}^{1} x^3 \, dx = \left[\frac{x^4}{4}\right]_{-1}^{1} = \frac{1}{4} - \frac{1}{4} = 0$

# Q.1.10 [1 mark]

$\int \frac{1}{1+x^2}\,dx =$ _

**Answer**: d. $\tan^{-1} x$

**Solution**:
$\int \frac{1}{1+x^2}\,dx = \tan^{-1} x + C$

## Q.1.11 [1 mark]

**Order of the differential equation $\frac{d^2y}{dx^2} - y = 0$ is ___.**

**Answer**: b. 2

**Solution**:
The highest derivative is $\frac{d^2y}{dx^2}$, so the order is 2.

## Q.1.12 [1 mark]

**The integration factor (I.F) of $\frac{dy}{dx} + Py = Q$ is ___**

**Answer**: a. $e^{\int P\,dx}$

**Solution**:
For a linear differential equation $\frac{dy}{dx} + Py = Q$, the integrating factor is $e^{\int P\,dx}$.

## Q.1.13 [1 mark]

**If $Z = 4 - 5i$ then $\bar{Z} =$ ___**

**Answer**: c. $4 - 5i$

**Solution**:
Wait, this seems incorrect. If $Z = 4 - 5i$, then $\bar{Z} = 4 + 5i$.
The correct answer should be $4 + 5i$.

## Q.1.14 [1 mark]

$i^{10} =$ _

**Answer**: b. -1

**Solution**:
$i^{10} = i^{4\cdot 2+2} = (i^4)^2 \cdot i^2 = 1^2 \cdot (-1) = -1$

# Q.2 (A) [6 marks]

**Attempt any two.**

## Q.2(A).1 [3 marks]

**If $A = \begin{bmatrix} 2 & -1 \\ 4 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 2 \\ 1 & 4 \end{bmatrix}$ then find the matrix X such that $2A + X = 3B$.**

**Solution**:
$2A + X = 3B$
$X = 3B - 2A$

$2A = 2\begin{bmatrix} 2 & -1 \\ 4 & 3 \end{bmatrix} = \begin{bmatrix} 4 & -2 \\ 8 & 6 \end{bmatrix}$

$3B = 3\begin{bmatrix} 3 & 2 \\ 1 & 4 \end{bmatrix} = \begin{bmatrix} 9 & 6 \\ 3 & 12 \end{bmatrix}$

$X = \begin{bmatrix} 9 & 6 \\ 3 & 12 \end{bmatrix} - \begin{bmatrix} 4 & -2 \\ 8 & 6 \end{bmatrix} = \begin{bmatrix} 5 & 8 \\ -5 & 6 \end{bmatrix}$

## Q.2(A).2 [3 marks]

**If** $A = \begin{bmatrix} 5 & 4 \\ 4 & 3 \end{bmatrix}$ **and** $B = \begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}$ **then find** $(AB)^T$**.**

**Solution**:
First, find $AB$:
$AB = \begin{bmatrix} 5 & 4 \\ 4 & 3 \end{bmatrix}\begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}$

$AB = \begin{bmatrix} 5(1) + 4(2) & 5(3) + 4(1) \\ 4(1) + 3(2) & 4(3) + 3(1) \end{bmatrix} = \begin{bmatrix} 13 & 19 \\ 10 & 15 \end{bmatrix}$

$(AB)^T = \begin{bmatrix} 13 & 10 \\ 19 & 15 \end{bmatrix}$

## Q.2(A).3 [3 marks]

**Solve:** $\frac{dy}{dx} = x^2 \cdot e^{-y}$**.**

**Solution**:
$\frac{dy}{dx} = x^2 \cdot e^{-y}$

Separating variables:
$e^y\,dy = x^2\,dx$

Integrating both sides:
$\int e^y\,dy = \int x^2\,dx$

$e^y = \frac{x^3}{3} + C$

$y = \ln\left(\frac{x^3}{3} + C\right)$

# Q.2 (B) [8 marks]

**Attempt any two.**

## Q.2(B).1 [4 marks]

**If** $A = \begin{bmatrix} 2 & 3 & -1 \\ 4 & 5 & 0 \end{bmatrix}$ **and** $B = \begin{bmatrix} 1 & 2 & 4 \\ 2 & 3 & 1 \end{bmatrix}$ **then prove that** $(A+B)^T = A^T + B^T$**.**

**Solution**:
$A + B = \begin{bmatrix} 2 & 3 & -1 \\ 4 & 5 & 0 \end{bmatrix} + \begin{bmatrix} 1 & 2 & 4 \\ 2 & 3 & 1 \end{bmatrix}$

$A + B = \begin{bmatrix} 3 & 5 & 3 \\ 6 & 8 & 1 \end{bmatrix}$

$(A + B)^T = \begin{bmatrix} 3 & 6 \\ 5 & 8 \\ 3 & 1 \end{bmatrix}$

$A^T = \begin{bmatrix} 2 & 4 \\ 3 & 5 \\ -1 & 0 \end{bmatrix}$, $B^T = \begin{bmatrix} 1 & 2 \\ 2 & 3 \\ 4 & 1 \end{bmatrix}$

$A^T + B^T = \begin{bmatrix} 2 & 4 \\ 3 & 5 \\ -1 & 0 \end{bmatrix} + \begin{bmatrix} 1 & 2 \\ 2 & 3 \\ 4 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 6 \\ 5 & 8 \\ 3 & 1 \end{bmatrix}$

Therefore, $(A + B)^T = A^T + B^T$ is proved.

## Q.2(B).2 [4 marks]

**If $A = \begin{bmatrix} 2 & -1 & 0 \\ 1 & 0 & 4 \\ 1 & -1 & 1 \end{bmatrix}$ then find $A^{-1}$.**

**Solution**:
To find $A^{-1}$, we use the formula $A^{-1} = \frac{1}{|A|} \cdot \text{adj}(A)$

First, find $|A|$:
$|A| = 2(0 \cdot 1 - 4 \cdot (-1)) - (-1)(1 \cdot 1 - 4 \cdot 1) + 0(1 \cdot (-1) - 0 \cdot 1)$
$|A| = 2(4) + 1(-3) = 8 - 3 = 5$

Next, find cofactors:
$C_{11} = (-1)^{1+1} \begin{vmatrix} 0 & 4 \\ -1 & 1 \end{vmatrix} = 4$

$C_{12} = (-1)^{1+2} \begin{vmatrix} 1 & 4 \\ 1 & 1 \end{vmatrix} = -(-3) = 3$

$C_{13} = (-1)^{1+3} \begin{vmatrix} 1 & 0 \\ 1 & -1 \end{vmatrix} = -1$

$C_{21} = (-1)^{2+1} \begin{vmatrix} -1 & 0 \\ -1 & 1 \end{vmatrix} = -(-1) = 1$

$C_{22} = (-1)^{2+2} \begin{vmatrix} 2 & 0 \\ 1 & 1 \end{vmatrix} = 2$

$C_{23} = (-1)^{2+3} \begin{vmatrix} 2 & -1 \\ 1 & -1 \end{vmatrix} = -(-1) = 1$

$$C_{31} = (-1)^{3+1} \begin{vmatrix} -1 & 0 \\ 0 & 4 \end{vmatrix} = -4$$

$$C_{32} = (-1)^{3+2} \begin{vmatrix} 2 & 0 \\ 1 & 4 \end{vmatrix} = -(8) = -8$$

$$C_{33} = (-1)^{3+3} \begin{vmatrix} 2 & -1 \\ 1 & 0 \end{vmatrix} = 1$$

$$\text{adj}(A) = \begin{bmatrix} 4 & 1 & -4 \\ 3 & 2 & -8 \\ -1 & 1 & 1 \end{bmatrix}$$

$$A^{-1} = \frac{1}{5} \begin{bmatrix} 4 & 1 & -4 \\ 3 & 2 & -8 \\ -1 & 1 & 1 \end{bmatrix}$$

## Q.2(B).3 [4 marks]

**Solve the equations $3x - y = 1, x + 2y = 5$ by matrix method.**

**Solution**:
The system can be written as $AX = B$ where:
$A = \begin{bmatrix} 3 & -1 \\ 1 & 2 \end{bmatrix}$, $X = \begin{bmatrix} x \\ y \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 5 \end{bmatrix}$

$$|A| = 3(2) - (-1)(1) = 6 + 1 = 7$$

$$A^{-1} = \frac{1}{7} \begin{bmatrix} 2 & 1 \\ -1 & 3 \end{bmatrix}$$

$$X = A^{-1}B = \frac{1}{7} \begin{bmatrix} 2 & 1 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} 1 \\ 5 \end{bmatrix}$$

$$X = \frac{1}{7} \begin{bmatrix} 2 + 5 \\ -1 + 15 \end{bmatrix} = \frac{1}{7} \begin{bmatrix} 7 \\ 14 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

Therefore, $x = 1$ and $y = 2$.

# Q.3 (A) [6 marks]

**Attempt any two.**

## Q.3(A).1 [3 marks]

**If $y = \frac{e^x+1}{e^x-1}$ then find $\frac{dy}{dx}$.**

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

Let $u = e^x + 1$ and $v = e^x - 1$
$\frac{du}{dx} = e^x$ and $\frac{dv}{dx} = e^x$

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

$= \frac{e^{2x}-e^x-e^{2x}-e^x}{(e^x-1)^2} = \frac{-2e^x}{(e^x-1)^2}$

## Q.3(A).2 [3 marks]

**If $x = a\cos\theta, y = b\sin\theta$ then find $\frac{dy}{dx}$.**

**Solution**:
$\frac{dx}{d\theta} = -a\sin\theta$
$\frac{dy}{d\theta} = b\cos\theta$

$\frac{dy}{dx} = \frac{dy/d\theta}{dx/d\theta} = \frac{b\cos\theta}{-a\sin\theta} = -\frac{b\cos\theta}{a\sin\theta} = -\frac{b}{a}\cot\theta$

## Q.3(A).3 [3 marks]

**Evaluate: $\int \frac{\cos\sqrt{x}}{2\sqrt{x}}dx$.**

**Solution**:
Let $u = \sqrt{x}$, then $du = \frac{1}{2\sqrt{x}}dx$

$\int \frac{\cos\sqrt{x}}{2\sqrt{x}}dx = \int \cos u\, du = \sin u + C = \sin\sqrt{x} + C$

# Q.3 (B) [8 marks]

**Attempt any two.**

## Q.3(B).1 [4 marks]

**Differentiate $y = x^{\cos x}$ with respect to x.**

**Solution**:
Taking natural logarithm on both sides:
$\ln y = \cos x \ln x$

Differentiating both sides with respect to x:
$\frac{1}{y}\frac{dy}{dx} = \cos x \cdot \frac{1}{x} + \ln x \cdot (-\sin x)$

$\frac{dy}{dx} = y\left(\frac{\cos x}{x} - \sin x \ln x\right)$

$\frac{dy}{dx} = x^{\cos x}\left(\frac{\cos x}{x} - \sin x \ln x\right)$

## Q.3(B).2 [4 marks]

**If $y = A\cos pt + B\sin pt$, prove that $\frac{d^2y}{dt^2} + p^2y = 0$.**

**Solution**:
$y = A\cos pt + B\sin pt$

$\frac{dy}{dt} = -Ap\sin pt + Bp\cos pt$

$\frac{d^2y}{dt^2} = -Ap^2\cos pt - Bp^2\sin pt = -p^2(A\cos pt + B\sin pt) = -p^2y$

Therefore: $\frac{d^2y}{dt^2} + p^2y = -p^2y + p^2y = 0$

### Q.3(B).3 [4 marks]

**The equation of motion of a particle is $s = t^3 + 2t^2 - 3t + 5$. Find the velocity and acceleration of the particle at $t = 1$ and $t = 2$ seconds.**

**Solution**:
$s = t^3 + 2t^2 - 3t + 5$

Velocity: $v = \frac{ds}{dt} = 3t^2 + 4t - 3$

Acceleration: $a = \frac{dv}{dt} = 6t + 4$

At $t = 1$:
$v(1) = 3(1)^2 + 4(1) - 3 = 3 + 4 - 3 = 4$ units/sec
$a(1) = 6(1) + 4 = 10$ units/sec²

At $t = 2$:
$v(2) = 3(2)^2 + 4(2) - 3 = 12 + 8 - 3 = 17$ units/sec
$a(2) = 6(2) + 4 = 16$ units/sec²

## Q.4 (A) [6 marks]

**Attempt any two.**

### Q.4(A).1 [3 marks]

**Evaluate: $\int x \log x \, dx$.**

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

Let $u = \log x$ and $dv = x \, dx$
Then $du = \frac{1}{x} dx$ and $v = \frac{x^2}{2}$

$\int x \log x \, dx = \log x \cdot \frac{x^2}{2} - \int \frac{x^2}{2} \cdot \frac{1}{x} dx$

$= \frac{x^2 \log x}{2} - \int \frac{x}{2} dx$

$= \frac{x^2 \log x}{2} - \frac{x^2}{4} + C$

$= \frac{x^2}{2}(\log x - \frac{1}{2}) + C$

### Q.4(A).2 [3 marks]

**Evaluate: $\int_{-1}^{1} \frac{1}{1+x^2} dx$.**

**Solution**:
$\int_{-1}^{1} \frac{1}{1+x^2} dx = [\tan^{-1} x]_{-1}^{1}$

$= \tan^{-1}(1) - \tan^{-1}(-1)$

$= \frac{\pi}{4} - \left(-\frac{\pi}{4}\right) = \frac{\pi}{2}$

### Q.4(A).3 [3 marks]

**Find inverse of $Z = 3 + 4i$.**

**Solution**:
$Z^{-1} = \frac{1}{Z} = \frac{1}{3+4i}$

Multiply numerator and denominator by the conjugate:
$Z^{-1} = \frac{1}{3+4i} \cdot \frac{3-4i}{3-4i} = \frac{3-4i}{(3)^2+(4)^2} = \frac{3-4i}{9+16} = \frac{3-4i}{25}$

$Z^{-1} = \frac{3}{25} - \frac{4}{25}i$

# Q.4 (B) [8 marks]

**Attempt any two.**

## Q.4(B).1 [4 marks]

**Evaluate: $\int_0^{\pi/2} \frac{\tan x}{\tan x + \cot x} dx$.**

**Solution**:
Let $I = \int_0^{\pi/2} \frac{\tan x}{\tan x + \cot x} dx$

Using the property $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$:

$I = \int_0^{\pi/2} \frac{\tan(\pi/2 - x)}{\tan(\pi/2 - x) + \cot(\pi/2 - x)} dx$

$= \int_0^{\pi/2} \frac{\cot x}{\cot x + \tan x} dx$

Adding the two expressions:
$2I = \int_0^{\pi/2} \frac{\tan x + \cot x}{\tan x + \cot x} dx = \int_0^{\pi/2} 1\, dx = \frac{\pi}{2}$

Therefore: $I = \frac{\pi}{4}$

## Q.4(B).2 [4 marks]

**Find the area bounded by the line $y = x$, $x = 5$ and the X-axis.**

**Solution**:
The region is bounded by $y = x$, $x = 5$, and $y = 0$ (X-axis).

Area = $\int_0^5 x\, dx = \left[\frac{x^2}{2}\right]_0^5 = \frac{25}{2} - 0 = \frac{25}{2}$ square units

## Q.4(B).3 [4 marks]

**If $x + iy = \left(\frac{1+i}{2-i}\right)^2$, find the value of $x + y$.**

**Solution**:
First, simplify $\frac{1+i}{2-i}$:
$\frac{1+i}{2-i} \cdot \frac{2+i}{2+i} = \frac{(1+i)(2+i)}{(2-i)(2+i)} = \frac{2+i+2i+i^2}{4-i^2} = \frac{2+3i-1}{4+1} = \frac{1+3i}{5}$

Now: $\left(\frac{1+3i}{5}\right)^2 = \frac{(1+3i)^2}{25} = \frac{1+6i+9i^2}{25} = \frac{1+6i-9}{25} = \frac{-8+6i}{25}$

Therefore: $x = -\frac{8}{25}$ and $y = \frac{6}{25}$

$x + y = -\frac{8}{25} + \frac{6}{25} = -\frac{2}{25}$

# Q.5 (A) [6 marks]

**Attempt any two.**

## Q.5(A).1 [3 marks]

**Find Square root of $Z = 5 + 12i$.**

**Solution**:
Let $\sqrt{5+12i} = a + bi$ where $a, b \in \mathbb{R}$

$(a + bi)^2 = 5 + 12i$
$a^2 + 2abi + b^2i^2 = 5 + 12i$
$(a^2 - b^2) + 2abi = 5 + 12i$

Comparing real and imaginary parts:
$a^2 - b^2 = 5$ ... (1)
$2ab = 12$ ... (2)

From (2): $b = \frac{6}{a}$

Substituting in (1): $a^2 - \frac{36}{a^2} = 5$
$a^4 - 5a^2 - 36 = 0$

Let $u = a^2$: $u^2 - 5u - 36 = 0$
$(u - 9)(u + 4) = 0$

Since $u = a^2 \geq 0$, we have $u = 9$, so $a = \pm 3$

If $a = 3$, then $b = 2$
If $a = -3$, then $b = -2$

Therefore: $\sqrt{5+12i} = \pm(3 + 2i)$

## Q.5(A).2 [3 marks]

**Find $x, y \in \mathbb{R}$ from the equation $(2x - y) + yi = 6 + 4i$.**

**Solution**:
Comparing real and imaginary parts:
Real part: $2x - y = 6$ ... (1)
Imaginary part: $y = 4$ ... (2)

Substituting (2) into (1):
$2x - 4 = 6$
$2x = 10$
$x = 5$

Therefore: $x = 5$ and $y = 4$

## Q.5(A).3 [3 marks]

**Find the modulus and principal argument of $Z = 1 + i$, and express Z into the polar form.**

**Solution**:
$Z = 1 + i$

Modulus: $|Z| = \sqrt{1^2 + 1^2} = \sqrt{2}$

Principal argument: $\arg(Z) = \tan^{-1}\left(\frac{1}{1}\right) = \tan^{-1}(1) = \frac{\pi}{4}$

Polar form: $Z = |Z|(\cos\theta + i\sin\theta) = \sqrt{2}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$

## Q.5 (B) [8 marks]

**Attempt any two.**

### Q.5(B).1 [4 marks]

**Solve: $\frac{dy}{dx} = 1 + x + y + xy$.**

**Solution**:
$\frac{dy}{dx} = 1 + x + y + xy = (1 + x) + y(1 + x) = (1 + x)(1 + y)$

Separating variables:
$\frac{dy}{1+y} = (1 + x)dx$

Integrating both sides:
$\int \frac{dy}{1+y} = \int (1 + x)dx$

$\ln|1 + y| = x + \frac{x^2}{2} + C$

$1 + y = Ae^{x+x^2/2}$ where $A = e^C$

$y = Ae^{x+x^2/2} - 1$

### Q.5(B).2 [4 marks]

**Solve the differential equation: $\frac{dy}{dx} + y = e^x$.**

**Solution**:
This is a first-order linear differential equation of the form $\frac{dy}{dx} + Py = Q$ where $P = 1$ and $Q = e^x$.

Integrating factor: $I.F. = e^{\int P\,dx} = e^{\int 1\,dx} = e^x$

Multiplying the equation by $e^x$:
$e^x\frac{dy}{dx} + e^x y = e^{2x}$

$\frac{d}{dx}(ye^x) = e^{2x}$

Integrating both sides:
$ye^x = \int e^{2x}dx = \frac{e^{2x}}{2} + C$

$y = \frac{e^x}{2} + Ce^{-x}$

### Q.5(B).3 [4 marks]

**Solve the differential equation:** $\frac{dy}{dx} - y\tan x = 1$.

**Solution**:
This is a first-order linear differential equation where $P = -\tan x$ and $Q = 1$.

Integrating factor: $I.F. = e^{\int(-\tan x)dx} = e^{\ln|\cos x|} = \cos x$

Multiplying the equation by $\cos x$:
$\cos x\frac{dy}{dx} - y\cos x\tan x = \cos x$

$\cos x\frac{dy}{dx} - y\sin x = \cos x$

$\frac{d}{dx}(y\cos x) = \cos x$

Integrating both sides:
$y\cos x = \int\cos x\,dx = \sin x + C$

$y = \tan x + \frac{C}{\cos x} = \tan x + C\sec x$

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# Formula Cheat Sheet

## Matrix Operations

- **Order of Matrix**: If matrix has $m$ rows and $n$ columns, order is $m \times n$
- **Matrix Multiplication**: $(AB)_{ij} = \sum_k A_{ik}B_{kj}$
- **Transpose**: $(A^T)_{ij} = A_{ji}$
- **Adjoint of 2×2 Matrix**: If $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, then $\text{adj}(A) = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$
- **Inverse**: $A^{-1} = \frac{1}{|A|} \cdot \text{adj}(A)$

## Differentiation

- $\frac{d}{dx}(e^x) = e^x$
- $\frac{d}{dx}(\ln x) = \frac{1}{x}$
- $\frac{d}{dx}(x^n) = nx^{n-1}$
- $\frac{d}{dx}(\sin x) = \cos x$
- $\frac{d}{dx}(\cos x) = -\sin x$
- **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**: $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{u'v-uv'}{v^2}$
- **Parametric**: If $x = f(t)$ and $y = g(t)$, then $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$

## Integration

- $\int x^n\,dx = \frac{x^{n+1}}{n+1} + C$ (for $n \neq -1$)

- $\int e^x \, dx = e^x + C$
- $\int \frac{1}{x} \, dx = \ln |x| + C$
- $\int \sin x \, dx = -\cos x + C$
- $\int \cos x \, dx = \sin x + C$
- $\int \frac{1}{1+x^2} \, dx = \tan^{-1} x + C$
- **Integration by Parts**: $\int u \, dv = uv - \int v \, du$
- **Definite Integration**: $\int_a^b f(x) \, dx = F(b) - F(a)$ where $F'(x) = f(x)$

## Differential Equations

- **Order**: Highest derivative present
- **Degree**: Power of highest derivative
- **Linear DE**: $\frac{dy}{dx} + Py = Q$
- **Integrating Factor**: $I.F. = e^{\int P \, dx}$
- **Variable Separable**: $\frac{dy}{dx} = f(x)g(y) \to \frac{dy}{g(y)} = f(x)dx$

## Complex Numbers

- **Standard Form**: $z = a + bi$
- **Conjugate**: $\overline{a + bi} = a - bi$
- **Modulus**: $|a + bi| = \sqrt{a^2 + b^2}$
- **Argument**: $\arg(z) = \tan^{-1}\left(\frac{b}{a}\right)$
- **Polar Form**: $z = r(\cos\theta + i\sin\theta)$ where $r = |z|$ and $\theta = \arg(z)$
- **Powers of i**: $i^1 = i$, $i^2 = -1$, $i^3 = -i$, $i^4 = 1$
- **Inverse**: $z^{-1} = \frac{\bar{z}}{|z|^2}$

# Problem-Solving Strategies

## Matrix Problems

1. **Check dimensions** before multiplication
2. **Use properties**: $(AB)^T = B^T A^T$, $(A+B)^T = A^T + B^T$
3. **For inverse**: Calculate determinant first, then adjoint
4. **System of equations**: Write as $AX = B$, solve $X = A^{-1}B$

## Differentiation Problems

1. **Identify the type**: Basic, chain rule, product rule, quotient rule
2. **For implicit**: Differentiate both sides with respect to x

3. **For parametric**: Use $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$
4. **For logarithmic**: Take ln of both sides first

## Integration Problems

1. **Check standard forms** first
2. **For products**: Try integration by parts (ILATE rule)
3. **For rational functions**: Check for substitution
4. **For definite integrals**: Use properties like $\int_{-a}^{a} f(x)dx = 0$ if f(x) is odd

## Differential Equations

1. **Identify type**: Order, degree, linear/non-linear
2. **For linear DE**: Find integrating factor
3. **For separable**: Separate variables and integrate
4. **Check initial conditions** if given

## Complex Numbers

1. **For operations**: Use standard form $a + bi$
2. **For modulus/argument**: Convert to polar form
3. **For powers**: Use De Moivre's theorem
4. **For square roots**: Let $\sqrt{a + bi} = c + di$ and solve

# Common Mistakes to Avoid

1. **Matrix multiplication**: Remember $AB \neq BA$ in general
2. **Chain rule**: Don't forget to multiply by derivative of inner function
3. **Integration**: Remember the constant of integration
4. **Definite integrals**: Apply limits correctly
5. **Complex numbers**: $i^2 = -1$, not $+1$
6. **Differential equations**: Don't forget integrating factor for linear DE
7. **Parametric differentiation**: Use $\frac{dy/dt}{dx/dt}$, not $\frac{dt/dy}{dt/dx}$

# Exam Tips

## Time Management

- **Q.1 (MCQs)**: Spend 15-20 minutes maximum
- **Short answers**: 3-4 minutes per question
- **Long answers**: 8-10 minutes per question

- **Keep 10 minutes** for final review

## Strategy

1. **Read all questions** first to identify easy ones
2. **Attempt easy questions** first to build confidence
3. **Show all steps** clearly for partial marks
4. **Check units** in application problems
5. **Verify answers** where possible (especially in matrix problems)

## During Exam

- **Write clearly** and organize solutions
- **Draw diagrams** where helpful
- **State formulas** before using them
- **Don't panic** if stuck on one question - move to next
- **Use remaining time** to review and check calculations

**Good Luck with your exams!**