

## CS &amp; DA

DPP:03

## LINEAR ALGEBRA

**Q1** The eigen values of the matrix  $\begin{pmatrix} a & 1 \\ a & 1 \end{pmatrix}$  are :

- (A)  $(a+1), 0$       (B)  $a, 0$   
 (C)  $(a-1), 0$       (D)  $0, 0$

**Q2** Consider  $M = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$

The eigenvalues of M are

- (A)  $0, 1, 2$       (B)  $0, 0, 3$   
 (C)  $1, 1, 1$       (D)  $-1, 1, 3$

**Q3** Consider the matrix

$$M = \begin{pmatrix} 0 & 2i & 3i \\ -2i & 0 & 6i \\ -3i & -6i & 0 \end{pmatrix}$$

The eigenvalues of M are

- (A)  $-5, -2, 7$   
 (B)  $-7, 0, 7$   
 (C)  $-4i, 2i, 2i$   
 (D)  $2, 3, 6$

**Q4** The eigenvalues of the matrix  $\begin{pmatrix} 1 & i \\ -i & 1 \end{pmatrix}$  are

- (A)  $+1$  and  $+1$   
 (B) Zero and  $+1$   
 (C) Zero and  $+2$   
 (D)  $-1$  and  $+1$

**Q5** The eigenvalues of  $(A^4 + 3A - 2I)$ , where A is

$$A = \begin{pmatrix} 1 & 1 & 1 \\ 0 & 2 & 1 \\ 0 & 0 & 3 \end{pmatrix}, \text{ are}$$

- (A)  $2, 20, 88$       (B)  $1, 2, 3$   
 (C)  $2, 20, 3$       (D)  $1, 20, 88$

**Q6**

Eigen value of matrix  
 $\begin{pmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -2i \\ 0 & 0 & 2i & 0 \end{pmatrix}$  are

- (A)  $-2, -1, 1, 2$   
 (B)  $-1, 1, 0, 2$   
 (C)  $1, 0, 2, 7$   
 (D)  $-1, 1, 0, 3$

**Q7** The eigenvalues of a matrix are  $i, -2i$  and  $3i$ .

The matrix is

- (A) Unitary      (B) Anti-Unitary  
 (C) Hermitian      (D) Anti-Hermitian

**Q8** The eigenvalue of the matrix  $A = \begin{pmatrix} 0 & i \\ i & 0 \end{pmatrix}$  are

- (A) Real and Distinct  
 (B) Complex and Distinct  
 (C) Complex and Coinciding  
 (D) Real and Coinciding

**Q9** The eigen values of the matrix  $\begin{pmatrix} 2 & 3 & 0 \\ 3 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$  are

- (A)  $5, 2, -2$   
 (B)  $-5, -1$   
 (C)  $5, 1, -1$   
 (D)  $-5, 1$

**Q10** A  $3 \times 3$  matrix has element such that its trace is 11 and its determinant is 36. The eigenvalues of the matrix are all known to be positive integers.

The largest eigenvalue of the matrix is:

- (A) 18      (B) 12  
 (C) 9      (D) 6

**Q11**



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The eigenvalues of the matrix  $\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$  are

(A)  $0, 1, 1$   
 (B)  $0, -\sqrt{2}, \sqrt{2}$   
 (C)  $\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0$   
 (D)  $\sqrt{2}, \sqrt{2}, 0$

- Q12** The trace of a  $2 \times 2$  matrix is 4 and its determinant is 8. If one of the eigenvalue is  $2(1 + i)$ , the other eigenvalue is
- (A)  $2(1 - i)$   
 (B)  $2(1 + i)$   
 (C)  $(1 + 2i)$   
 (D)  $(1 - 2i)$

- Q13** The eigenvalues of the matrix representing the following pair of linear equations

$$x + iy = 0$$

$$ix + y = 0$$

are

- (A)  $1 + i, 1 + i$   
 (B)  $1 - i, 1 - i$   
 (C)  $1, i$   
 (D)  $1+i, 1-i$

- Q14** If the matrix  $A = \begin{bmatrix} -1 & 2 & 3 \\ 0 & 3 & 5 \\ 0 & 0 & -2 \end{bmatrix}$  then the eigen values of  $A^2 + 5A + 8I$ , are :
- (A)  $-1, 27, -8$   
 (B)  $1, 3, -2$   
 (C)  $2, 32, 4$   
 (D)  $2, 50, 10$

- Q15** Two of the eigen values of a  $3 \times 3$  matrix, whose determinant equals 4, are -1 and +2 the third eigen value of the matrix is equal to :
- (A) -2  
 (B) -1  
 (C) 1  
 (D) 2

- Q16** If A is a singular hermitian matrix, then the least eigen value of  $A^2$  is :
- (A) 0  
 (B) 1  
 (C) 2  
 (D) None of these.

- Q17** If  $\lambda$  is an eigen value of matrix 'M' then for the matrix  $(M - \lambda I)$ ,  
 Which of the following statement (s) is/ are correct ?

- (A) Skew symmetric.  
 (B) Non singular.  
 (C) Singular.  
 (D) None of these.

- Q18** Let A be a matrix whose characteristic roots are  $3, 2, -1$ . If  $B = A^2 - A$  then  $|B| = \underline{\hspace{2cm}}$ .
- (A) 24  
 (B) -2  
 (C) 12  
 (D) -12

- Q19** The Eigen vector correseponding to the largest Eigen value of the matrix  $\begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$  is \_\_\_\_\_

- (A)  $\begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$   
 (B)  $\begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}$   
 (C)  $\begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$   
 (D) None.

- Q20** The Eigen vector of the matrix  $\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$  are :  
 (A)  $(1, 0)$   
 (B)  $(0, 1)$   
 (C)  $(1, 1)$   
 (D)  $(1, -1)$

- Q21** The vector  $\begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix}$  is an eigen vector of  $\begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$  then corresponding eigen values of A is :  
 (A) 1  
 (B) 2  
 (C) 5  
 (D) -1

- Q22** The column vector  $\begin{pmatrix} a \\ b \\ c \end{pmatrix}$  is a simultaneous eigenvector of  $A = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$  and  $B = \underline{\hspace{2cm}}$



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$$\begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix} \text{ if }$$

- (A)  $b = 0$  or  $a = 0$   
 (B)  $b = 0$  or  $a = -c$   
 (C)  $b = 2a$  or  $b = -a$   
 (D)  $b = a/2$  or  $b = -a/2$

**Q23** A linear transformation  $T$ , defined as

$$T \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} x_1 + x_2 \\ x_2 - x_3 \end{pmatrix}, \text{ transform a}$$

vector  $\vec{x}$  three dimensional space to a two-dimensional real space. The transformation matrix  $T$  is

- (A)  $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & -1 \end{pmatrix}$   
 (B)  $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$   
 (C)  $\begin{pmatrix} 1 & 1 & 1 \\ -1 & 1 & 1 \end{pmatrix}$   
 (D)  $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

**Q24** The eigenvalues and eigenvectors of the

$$\text{matrix } \begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix} \text{ are}$$

- (A) 6,1 and  $\begin{bmatrix} 4 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}$   
 (B) 2,5 and  $\begin{bmatrix} 4 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}$   
 (C) 6,2 and  $\begin{bmatrix} 4 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}$   
 (D) 2,5 and  $\begin{bmatrix} 4 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

**Q25** (i) The eigen vectors  $X$  of a matrix  $A$ , is not

$$\text{a) } X'_1 X_2 = 0$$

(ii) Two eigen vectors  $X_1$  and  $X_2$  are called orthogonal if

$$\sqrt{\lambda_1^2 + \lambda_2^2 + \lambda_3^2}$$

(iii) Normalised form of vectors  $\begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{bmatrix}$  is obtained on dividing each element by,

c)unique

(iv) Every square matrix satisfies its own.

d)Characteristic

equation

(A) (i)-c

(ii)-a

(iii)-b

(iv)-d

(B) (i)-a

(ii)-c

(iii)-b

(iv)-d

(C) (i)-c

(ii)-a

(iii)-d

(iv)-b

(D) (i)-c

(ii)-d

(iii)-b

(iv)-a

**Q26** Calculate the matrix  $A^2$ , by the use of Cayley – Hamilton theorem (or) otherwise is :

$$A = \begin{vmatrix} 1 & 0 & 0 & 1 \\ 0 & -1 & 0 & -1 \\ 0 & 0 & i & 1 \\ 0 & 0 & 0 & -i \end{vmatrix} \quad 1$$

**Q27** The matrix  $A = \begin{bmatrix} 1 & 0 \\ 2 & 4 \end{bmatrix}$  is given and the eigen values of  $4A^{-1} + 3A + 2I$  are.

- (A) 6,15  
 (B) 9,12  
 (C) 9,15  
 (D) 7,15

**Q28** In matrix  $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$  if  $a + d = ad - bc = 1$  then

- $A^3 = \dots$   
 (A)  $A - I$   
 (B)  $A + I$   
 (C)  $-I$   
 (D) 0

**Q29** Let  $A$  be an  $n \times n$  complex matrix whose characteristic polynomial is :

$$f(t) = t^n + c_{n-1}t^{n-1} + \dots + c_1t + c_0 \quad \text{then}$$

$$\det A = C_{n-1}$$



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- (B)  $\det A = C_0$   
 (C)  $\det A = (-1)^{n-1} C_{n-1}$   
 (D)  $\det A = (-1)^n C_0$

**Q30** The constant term of the characteristic polynomial of the matrix.

$$\begin{bmatrix} 1 & 2 & 6 & 5 \\ -1 & 3 & 2 & -5 \\ 2 & 4 & 12 & 10 \\ 3 & -2 & 1 & -4 \end{bmatrix} \text{ is } \underline{\hspace{2cm}}$$

**Q31** Two matrices A and B are said to be similar if  $B = P^{-1}AP$  for some invertible matrix P. Which of the following statements is NOT TRUE?

- (A)  $\text{Det } A = \text{Det } B$   
 (B) Trace of A = Trace of B  
 (C) A and B have the same eigenvectors  
 (D) A and B have the same eigenvalues

**Q32** If A and P be square matrices of the same type and if P is invertible, then the matrices A and  $P^{-1}AP$  have ..... characteristic roots.

**Q33** If  $A_{2 \times 2}$  s. t  $A \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$  &  $A \begin{bmatrix} 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 4 \\ 2 \end{bmatrix}$   
 then find A = ?

- |  |  |
|--|--|
| $(A) \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$ | $(B) \begin{bmatrix} 1 & 0 \\ 2 & 2 \end{bmatrix}$ |
| $(C) \begin{bmatrix} 1 & 2 \\ 0 & 2 \end{bmatrix}$ | $(D) \begin{bmatrix} 1 & 2 \\ 2 & 2 \end{bmatrix}$ |

**Q34** If  $A_{3 \times 3}$  then number of L. I Eigen vectors of A to have diagonalisation possible will be ?

- |         |                            |
|---------|----------------------------|
| $(A) 1$ | $(B) 2$                    |
| $(C) 3$ | $(D) \text{less than } 3.$ |



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## Answer Key

|         |                     |
|---------|---------------------|
| Q1 (A)  | Q18 (A)             |
| Q2 (B)  | Q19 (B)             |
| Q3 (B)  | Q20 (C)             |
| Q4 (C)  | Q21 (C)             |
| Q5 (A)  | Q22 (B)             |
| Q6 (A)  | Q23 (A)             |
| Q7 (D)  | Q24 (A)             |
| Q8 (B)  | Q25 (A)             |
| Q9 (C)  | Q26 IDENTITY MATRIX |
| Q10 (B) | Q27 (C)             |
| Q11 (B) | Q28 (C)             |
| Q12 (A) | Q29 (D)             |
| Q13 (D) | Q30 (0)             |
| Q14 (C) | Q31 (C)             |
| Q15 (A) | Q32 same            |
| Q16 (A) | Q33 (C)             |
| Q17 (C) | Q34 (C)             |



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## Hints & Solutions

**Q1 Text Solution:**

$$\text{Matrix } A = \begin{bmatrix} a & 1 \\ a & 1 \end{bmatrix}$$

Characteristic equation of matrix A,

$$|A - \lambda I| = 0$$

$$\Rightarrow \begin{vmatrix} a - \lambda & 1 \\ a & 1 - \lambda \end{vmatrix} = 0$$

$$\Rightarrow \lambda^2 - (a+1)\lambda + a - a = 0$$

$$\Rightarrow \lambda = 0, a+1.$$

Alternative Solution :

sum of eigen values = Trace of matrix

Hence option A is correct.

**Q2 Text Solution:**

$$M = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

The eigen values are given by –

$$|M - \lambda I| = 0$$

$$\text{Det of } \begin{pmatrix} 1 - \lambda & 1 & 1 \\ 1 & 1 - \lambda & 1 \\ 1 & 1 & 1 - \lambda \end{pmatrix} = 0$$

$$(1 - \lambda) \left( (1 - \lambda)^2 - 1 \right) - 1 \left( 1 - \lambda - 1 \right)$$

$$+ 1 \left( 1 - \left( 1 - \lambda \right) \right) = 0$$

$$(1 - \lambda) \left( -\lambda \left( 2 - \lambda \right) \right) + \lambda + \lambda = 0$$

$$\lambda = 0$$

$$(1 - \lambda) \left( \lambda - 2 \right) + 2 = 0$$

$$\lambda - 2 - \lambda^2 + 2\lambda + 2 = 0$$

$$3\lambda - \lambda^2 = 0$$

$$\lambda = 0, 3$$

**Q3 Text Solution:**

$$M = \begin{pmatrix} 0 & 2i & 3i \\ -2i & 0 & 6i \\ -3i & -6i & 0 \end{pmatrix}$$

$$|M - \lambda I| = 0$$

$$\begin{vmatrix} 0 - \lambda & 2i & 3i \\ -2i & -\lambda & 6i \\ -3i & -6i & -\lambda \end{vmatrix} = 0$$

$$-\lambda(\lambda^2 + 36i^2) - 2i(2i\lambda + 8i^2) + 3i(12i^2 - 3i\lambda) = 0$$

$$-\lambda^3 + 36i^2(-\lambda) - 4i^2\lambda - 36i^3 + 36i^3$$

$$-9i^2\lambda = 0$$

$$-\lambda^3 + 36\lambda + 4\lambda - 36i + 36i - 9\lambda = 0$$

$$\lambda^3 - 36\lambda - 4\lambda - 9\lambda = 0$$

$$\lambda^3 - 49\lambda = 0$$

$$\lambda^3 - (\lambda^2 - 49\lambda) = 0$$

$$\lambda = 0, 7, -7$$

(B) is Correct.

**Q4 Text Solution:**

$$M = \begin{pmatrix} 1 & i \\ -i & 1 \end{pmatrix}$$

$$|M - \lambda I| = 0$$

$$\begin{vmatrix} 1 - \lambda & i \\ -i & 1 - \lambda \end{vmatrix} = 0$$

$$(1 - \lambda)^2 + i^2 = 0$$

$$1 + \lambda^2 - 2\lambda - 1 = 0$$

$$\lambda^2 - 2\lambda = 0$$

$$\lambda - (\lambda - 2) = 0$$

$$\lambda = 0, 2$$

Option C is correct

**Q5 Text Solution:**

Eigen value of  $A^4 + 3A - 2I$  where.

$$A = \begin{pmatrix} 1 & 1 & 1 \\ 0 & 2 & 1 \\ 0 & 0 & 3 \end{pmatrix}$$

$$|A - \lambda I| = 0$$

$$\begin{vmatrix} 1 - \lambda & 1 & 1 \\ 0 & 2 - \lambda & 1 \\ 0 & 0 & 3 - \lambda \end{vmatrix}$$

$$(3 - \lambda)(2 - \lambda)(1 - \lambda) = 0$$

$$(\lambda - 1)(\lambda - 2)(\lambda - 3) = 0$$



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$$\lambda = 1, 2, 3$$

For  $\lambda = 1$ , eigen value of  $A^4 = 1, 3A = 3, 2I = 2$

thus, eigen values of  $A^4 + 3A - 2I = 1 + 3 - 2 = 2$

For  $\lambda = 2$ , eigen value of  $A^4 = 16, 3A = 6, 2I = 2$   
thus, eigen values of  $A^4 + 3A - 2I = 16 + 6 - 2 = 16 + 4 = 20$ .

For  $\lambda = 3$ , eigen value of  $A^4 = 81, 3A = 9, 2I = 2$

Thus the eigen values of-

$$A^4 + 3A - 2I = 81 + 9 - 2 = 88$$

Thus (A) is correct options.

#### Q6 Text Solution:

$$A = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -2i \\ 0 & 0 & 2i & 0 \end{pmatrix}$$

$$|A - \lambda I| = 0$$

$$\begin{vmatrix} 0 - \lambda & 1 & 0 & 0 \\ 1 & 0 - \lambda & 0 & 0 \\ 0 & 0 & 0 - \lambda & -2i \\ 0 & 0 & 2i & 0 - \lambda \end{vmatrix} = 0$$

$$(-\lambda) \begin{vmatrix} -\lambda & 0 & 0 \\ 0 & -\lambda & -2i \\ 0 & 2i & -\lambda \end{vmatrix} = (-\lambda)((-\lambda)(\lambda^2 + 4i^2)) - 1(\lambda^2 + 4i^2) = 0$$

$$(-\lambda)(-\lambda^3 + 4\lambda) - \lambda^2 + 4 = 0$$

$$\lambda^4 - 4\lambda^2 - \lambda^2 + 4$$

$$\lambda^4 - 5\lambda^2 + 4 = 0$$

$$(\lambda^2 - 1)(\lambda^2 - 4) = 0$$

$$\lambda^2 - 1 = 0 \rightarrow \lambda = \pm 1$$

$$\lambda^2 - 4 = 0 \rightarrow \lambda = \pm 2$$

$$\text{thus, } \lambda = +1, -1, +2, -2$$

Option (A) is correct.

#### Q7 Text Solution:

The eigen values are  $i, -2i, 3i$  All the eigen values are imaginary,

thus according to the property of anti-hermitian all the eigen values are either 0 or imaginary.

thus option (D) is the correct option.

#### Q8 Text Solution:

$$A = \begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$$

$$|A - \lambda I| = 0$$

$$\begin{vmatrix} 0 - \lambda & i \\ i & 0 - \lambda \end{vmatrix} = 0$$

$$\begin{vmatrix} -\lambda & i \\ i & -\lambda \end{vmatrix} = 0$$

$$\lambda^2 - i^2 = 0$$

$$\lambda^2 - 1 = 0$$

$$\lambda = \pm i$$

thus option (B) is correct.

#### Q9 Text Solution:

$$A = \begin{pmatrix} 2 & 3 & 0 \\ 3 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$|A - \lambda I| = 0$$

$$\begin{vmatrix} 2 - \lambda & 3 & 0 \\ 3 & 2 - \lambda & 0 \\ 0 & 0 & 1 - \lambda \end{vmatrix} = 0$$

$$(1 - \lambda)((2 - \lambda)^2 - 9) = 0$$

$$(1 - \lambda)(4 + \lambda^2 - 4\lambda - 9) = 0$$

$$(1 - \lambda)(+\lambda^2 - 4\lambda - 5) = 0$$

$$(1 - \lambda)(\lambda^2 - 4\lambda - 5) = 0$$

$$(\lambda - 1)((\lambda - 5)(\lambda + 1)) = 0$$

$$\lambda = 1, 5, -1$$

option (c) is correct.

#### Q10 Text Solution:

A matrix is of order  $3 \times 3$ .

Trace = 11

$$\{\lambda_1 = 11\}$$

$$\lambda_1 + \lambda_2 + \lambda_3 = 11$$

Determinant = 36

$$\lambda_1 \lambda_2 \lambda_3 = 36$$

thus option (d) will be the correct option.

as - 6, 3, 2

$6 + 3 + 2 = 11 \rightarrow$  sum of eigen values.

$6 \times 3 \times 2 = 36 \rightarrow$  product of eigen values.

#### Q11 Text Solution:



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$$M = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

$$|M - \lambda I| = 0$$

$$\begin{vmatrix} -\lambda & 1 & 0 \\ 1 & 0 - \lambda & 1 \\ 0 & 1 & 0 - \lambda \end{vmatrix} = 0$$

$$-\lambda \begin{pmatrix} -\lambda & 1 \\ 1 & -\lambda \end{pmatrix} - 1 \begin{pmatrix} 1 & 1 \\ 0 & -\lambda \end{pmatrix} = 0$$

$$-\lambda(\lambda^2 - 1) - 1(-\lambda) = 0$$

$$-\lambda^3 + \lambda + \lambda = 0$$

$$2\lambda - \lambda^3 = 0$$

$$\lambda^3 - 2\lambda = 0$$

$$\lambda(\lambda^2 - 2) = 0$$

$$\lambda = 0, +\sqrt{2}, -\sqrt{2}$$

Option B is correct.

#### **Q12 Text Solution:**

The trace of a  $2 \times 2$  matrix is 4, thus  $\lambda_1 + \lambda_2 = 4$ , 2 the determinant is product of eigen values thus  $\lambda_1 \cdot \lambda_2 = 8$

$$\lambda_1 + \lambda_2 = 4$$

$$\lambda_1 + 2 + 2i = 4$$

$$\lambda_1 + 2 + 2i = 2(1 - i)$$

Thus option A is correct.

#### **Q13 Text Solution:**

$$x + iy = 0$$

$$ix + y = 0$$

$$\begin{bmatrix} 1 & i \\ i & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = 0$$

$$\text{thus the matrix } A = \begin{bmatrix} 1 & i \\ i & 1 \end{bmatrix}$$

$$\begin{vmatrix} 1 - \lambda & i \\ i & 1 - \lambda \end{vmatrix} = 0$$

$$(1 - \lambda)^2 - i^2 = 0$$

$$1 + \lambda^2 - 2\lambda + 1 = 0$$

$$\lambda^2 - 2\lambda + 2 = 0$$

$$(\lambda - (1 + i))(\lambda - (1 - i)) = 0$$

$$\lambda = 1 + i, i - i$$

#### **Q14 Text Solution:**

$$A = \begin{bmatrix} -1 & 2 & 3 \\ 0 & 3 & 5 \\ 0 & 0 & -2 \end{bmatrix}$$

$$\begin{vmatrix} A - \lambda I \\ -1 - \lambda & 2 & 3 \\ 0 & 3 - \lambda & 5 \\ 0 & 0 & -2 - \lambda \end{vmatrix} = 0$$

$$(-2 - \lambda)(3 - \lambda)(-1 - \lambda) = 0$$

$$\lambda = -2$$

$$\lambda = 3$$

$$\lambda = -1$$

eigen value of  $A^2$  will be , 4, 9, 1

$$5 A \quad -10, 15, -5$$

$$8 I \quad 8, 8, 8$$

Now eigen value of  $A^2 + 5 A + 8 I$  will be

$$2, 32, 4$$

thus (c) is the correct option.

#### **Q15 Text Solution:**

$$\text{Now } \lambda_1 + \lambda_2 + \lambda_3 = -1 + 2 + \lambda_3$$

$$\lambda_1 \cdot \lambda_2 \cdot \lambda_3 = 4$$

$$-1 \cdot 2 \cdot \lambda_3 = 4$$

$$\lambda_3 = -2$$

thus (A) is the correct option.

#### **Q16 Text Solution:**

A is a singular hermitian matrix.

Thus all the eigen values of a hermitian matrix are always real.

And as the matrix is singular thus the determinant that is the product of eigen values are zero.

thus , the least eigen value of  $A^2$  is 0.

as all the eigen values of  $A^2$  will be greater than or equal to 0.

#### **Q17 Text Solution:**

If  $\lambda$  is an eigen value of M , then  $|M - \lambda \cdot I| = 0$  , that is the matrix  $B = M - \lambda \cdot I$  is singular.

#### **Q18 Text Solution:**

Therefore for A Eigen values are : 3 ,2,-1

for  $A^2$  the eigen values will be: 9,4,1

,



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$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = 3 \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

$$2a + b + c = 3a$$

$$a + 2b + c = 3b$$

$$c = 3c$$

$$\text{Thus } c = 0$$

putting  $c = 0$ ,

$$b = a$$

Thus the eigen vector,

$$\begin{bmatrix} a \\ a \\ 0 \end{bmatrix} = k \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}$$

Let  $k = 1$  thus the eigen vector is

$$\begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}$$

#### Q20 Text Solution:

$$A = \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$$

For eigen values :

$$|A - \lambda I| = 0$$

$$\Rightarrow \begin{vmatrix} 1 - \lambda & -1 \\ -1 & 1 - \lambda \end{vmatrix} = 0$$

$$1 + \lambda^2 - 2\lambda - 1 = 0$$

$$\lambda = 0, 2$$

For  $\lambda = 0$

$$A x = 0$$

$$\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$x - y = 0$$

$$y - x = 0$$

$$\Rightarrow y = x$$

$$\text{Let } x = k \Rightarrow y = k$$

$$\text{So, } X = \begin{bmatrix} k \\ k \end{bmatrix} = k \begin{bmatrix} 1 \\ 1 \end{bmatrix}, k \in \mathbb{R}$$

Hence option c is correct.

#### Q21 Text Solution:

If  $\lambda_1$  be the eigen value of matrix A and  $X_1$  the corresponding eigen vector then.

$$AX_1 = \lambda_1 X_1$$



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$$\Rightarrow \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix} = \begin{bmatrix} 5 \\ 10 \\ -5 \end{bmatrix}$$

$$= 5 \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix}$$

$\Rightarrow \lambda_1 = 5$  is the eigen value of A corresponding to the eigen vector  $[1 2 -1]^\top$

**Q22 Text Solution:**

$$A = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

Given that  $X = \begin{bmatrix} a \\ b \\ c \end{bmatrix}$  is an eigen vector of A.

$$AX = BX$$

$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

$$\begin{bmatrix} c \\ b \\ a \end{bmatrix} = \begin{bmatrix} b+c \\ a+c \\ a+b \end{bmatrix}$$

$$b = 0, a = -c$$

**Q23 Text Solution:**

Lrt us consider the matrix A

$$= \begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & -1 \end{pmatrix}$$

$$T \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} x_1 & + & x_2 \\ x_2 & - & x_3 \end{pmatrix}$$

$$TX = \begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & -1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$$

$$= \begin{pmatrix} x_1 & + & x_2 \\ x_2 & - & x_3 \end{pmatrix}$$

Thus A is the correct option.

**Q24 Text Solution:**

The eigen value of the matrix A

$$= \begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$$

are –

$$|A - \lambda I| = 0$$

$$\begin{vmatrix} 5 - \lambda & 4 \\ 1 & 2 - \lambda \end{vmatrix} = 0$$

$$(5 - \lambda)(2 - \lambda) - 4 = 0$$

$$10 - 5\lambda - 2\lambda + \lambda^2 - 4 = 0$$

$$\lambda^2 - 7\lambda + 6 = 0$$

$$(\lambda - 6)(\lambda - 1) = 0$$

6, 1 are the eigen values.

Let  $X = \begin{bmatrix} a \\ b \end{bmatrix}$  be the eigen value

corresponding to eigen value 1.

$$AX = 1 \cdot X$$

$$AX = X$$

$$\begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} a \\ b \end{bmatrix}$$

$$5a + 4b = a$$

$$4a + 4b = 0$$

$$a = -b$$

$$a + 2b = b$$

$$a = -b$$

Thus the eigen vector is  $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$

Let  $X = \begin{bmatrix} a \\ b \end{bmatrix}$  be the eigen value corresponding to eigen value 6.

$$AX = 6 \cdot X$$

$$AX = X$$

$$\begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 6a \\ 6b \end{bmatrix}$$

$$5a + 4b = 6a$$

$$4b = a$$

$$a + 2b = 6b$$

$$a = 4b$$

Thus the eigen vector is  $\begin{bmatrix} 4 \\ 1 \end{bmatrix}$

**Q25 Text Solution:**

The correct solution will be



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- (i)-c
- (ii)-a
- (iii)-b
- (iv)-d

**Q26 Text Solution:**

Given,

$$A = \begin{vmatrix} 1 & 0 & 0 & 1 \\ 0 & -1 & 0 & -1 \\ 0 & 0 & i & 1 \\ 0 & 0 & 0 & -i \end{vmatrix}$$

Since it is U.T.M So eigen values of A are  $\lambda = 1, -1, i, -i$

so C Eq. of A can be taken as.

$$(\lambda - 1)(\lambda + 1)(\lambda - i)(\lambda + i) = 0$$

$$\Rightarrow (\lambda^2 - 1)(\lambda^2 + 1) = 0$$

$$\Rightarrow \lambda^2 - 1 = 0$$

By Cayley Hamilton theorem , we can replace  $\lambda$  by A.

So,

$$A^2 - I = 0$$

$$A^2 = I.$$

**Q27 Text Solution:**

$$A = \begin{bmatrix} 1 & 0 \\ 2 & 4 \end{bmatrix}$$

The eigen value of A is –

$$\begin{vmatrix} 1 - \lambda & 0 \\ 2 & 4 - \lambda \end{vmatrix} = 0$$

$$(1 - \lambda)(4 - \lambda) = 0$$

$$\lambda = 1, 4$$

$$\text{Thus the eigen value of } A^{-1} = 1, 1/4, 3A = 3, 12 \text{ AND } 2I = 2, 2$$

$$4A^{-1} + 3A + 2I$$

First eigen value is –

$$4 + 3 + 2 = 9$$

second eigen value will be –

$$1 + 12 + 2 = 15$$

**Q28 Text Solution:**

We will form the characteristic equation thus –

$$\lambda^2 - \lambda + 1 = 0$$

According to the Cayley – Hamilton theorem every square matrix satisfies its own characteristic equation thus –

$$A^2 - A + I = 0$$

$$A^3 - A^2 + A = 0$$

$$A^3 = A^2 - A$$

$$A^3 = A - I - A$$

$$= -I$$

**Q29 Text Solution:**

Let A be an  $n \times n$  complex matrix whose characteristic polynomial is :

$$f(t) = t^n + c_{n-1}t^{n-1} + \dots + c_1t + c_0$$

$$f(t) = t^n - \text{trace } A t^{n-1} + \dots + c_1t + (-1)^n |A|$$

$$\text{Thus } \det A = (-1)^n C_0$$

**Q30 Text Solution:**

The constant term of a polynomial  $P(x)$  is its value when  $x = 0$ . By definition of the characteristic polynomial, its value when  $x = 0$  is the determinant of the matrix. Answer: The determinant of the matrix.

Now calculate the determinant value of the matrix we get–

$$\begin{bmatrix} 1 & 2 & 6 & 5 \\ -1 & 3 & 2 & -5 \\ 2 & 4 & 12 & 10 \\ 3 & -2 & 1 & -4 \end{bmatrix}$$

$R_1$  and  $R_3$  are equal thus the det is 0

**Q31 Text Solution:**

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Let  $P^{-1}AP = B$

$$\begin{aligned}|B - \lambda I| &= |P^{-1}AP - \lambda I| \\&= |P^{-1}AP - P^{-1}\lambda P| \\&= |P^{-1}(A - \lambda I)P| \\&= |(A - \lambda I)|\end{aligned}$$

They have the same eigen value.

Now,  $P^{-1}AP = B$

$$|P^{-1}AP| = |B|$$

$$|P^{-1}| |A| |P| = |B|$$

$$|A| = |B|$$

$$Tr(P^{-1}AP) = TrB$$

$$Tr(APP^{-1}) = TrB$$

$$Tr(AI) = TrB$$

$$TrA = TrB$$

### Q32 Text Solution:

Let  $P^{-1}AP = B$

$$\begin{aligned}|B - \lambda I| &= |P^{-1}AP - \lambda I| \\&= |P^{-1}AP - P^{-1}\lambda P| \\&= |P^{-1}(A - \lambda I)P| \\&= |(A - \lambda I)|\end{aligned}$$

### Q33 Text Solution:

$$A \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \text{ & } A \begin{bmatrix} 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 4 \\ 2 \end{bmatrix}$$

$$\text{Let } A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

$$\begin{aligned}\text{Now, } \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} &= \begin{bmatrix} 1 \\ 0 \end{bmatrix} \text{ and } \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} 2 \\ 1 \end{bmatrix} \\&= \begin{bmatrix} 4 \\ 2 \end{bmatrix}\end{aligned}$$

Solving them we get –

$$a = 1, c = 0, 2a + b = 4, 2c + d = 2$$

$$\text{Thus } b = 2, d = 2$$

$$\begin{bmatrix} 1 & 2 \\ 0 & 2 \end{bmatrix} = A$$

### Q34 Text Solution:

An  $n \times n$  matrix A is diagonalizable if and only if A has n linearly independent eigenvectors. Thus as the order of matrix is 3, thus the total number of LI eigen vectors will be 3.



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