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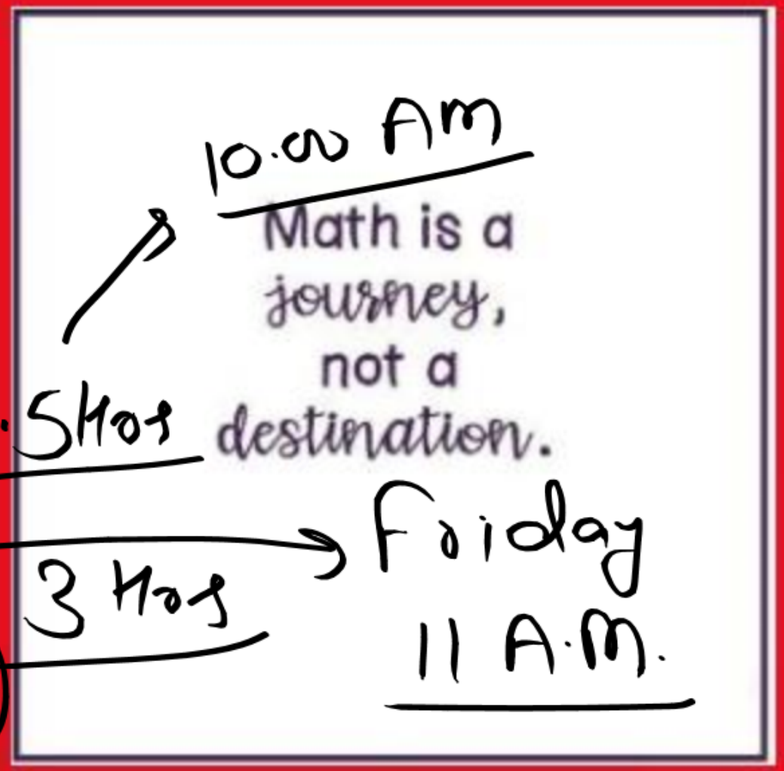

GATE 2024

GATE

प्रचण्ड Batch ALL BRANCH

ENGINEERING MATHEMATICS
EIGEN VECTORS

TIME- 10:00AM DATE- 11 APRIL 2023

ANANT SIR

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Q:109 Which one of the following is an eigenvector of the matrix

$$\begin{bmatrix} 5 & 0 & 0 & 0 \\ 0 & 5 & 5 & 0 \\ 0 & 0 & 2 & 1 \\ 0 & 0 & 3 & 1 \end{bmatrix}_{4\times4}$$

$\lambda_1, \lambda_2, \lambda_3, \lambda_4$

for 'λ' ← eigen value

eigen vector

$$[A-\lambda I]X = 0$$

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

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

(a) $\begin{bmatrix} 1 \\ -2 \\ 0 \\ 0 \end{bmatrix}_{4\times1}$

(b) $\begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}_{4\times1}$

(c) $\begin{bmatrix} 1 \\ 0 \\ 0 \\ -2 \end{bmatrix}_{4\times1}$

(d) $\begin{bmatrix} 1 \\ -1 \\ 2 \\ 1 \end{bmatrix}_{4\times1}$

$$\begin{bmatrix} 5 \\ 3 \\ 0 \\ 0 \end{bmatrix}$$

$$(5-\lambda)\left[(5-\lambda)\left[(2-\lambda)(1-\lambda)-3\right]\right]=0$$

$$(5-\lambda)^2[\ldots\ldots]=0$$

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

for $\lambda = 5$

$$[A-5I]X=0$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 5 & 0 \\ 0 & 0 & -3 & 1 \\ 0 & 0 & 3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = 0$$

$5x_3 = 0 \Rightarrow x_3 = 0$

$-3x_3 + x_4 = 0$

$\Rightarrow x_4 = 0$

$3x_3 - 4x_4 = 0$

$\Rightarrow x_3 = 0, x_4 = 0$

x_1 & x_2 → arbitrary

Q:110 The eigenvectors of the matrix $\begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix}_{2\times 2}$ are written in the form $\begin{bmatrix} 1 \\ a \end{bmatrix}$ and $\begin{bmatrix} 1 \\ b \end{bmatrix}$ What is a + b ?

$\lambda_1 = \lambda_2 = 2$

(a) 0

(b) 1/2

(c) 1

(d) 2

for $\lambda = 2$

$[A - 2I]X = 0$

$\begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$

$x_2 = 0$

$x_1 \rightarrow$ arbitrary

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

$\begin{bmatrix} 1 \\ 0 \end{bmatrix} \Rightarrow b = 0$

$a + b = 0$

Q:111 One of the eigen vectors of the matrix $A = \begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix}$ is -

(a) $\begin{Bmatrix} 2 \\ -1 \end{Bmatrix}$

(b) $\begin{Bmatrix} 2 \\ 1 \end{Bmatrix}$ ✗

(c) $\begin{Bmatrix} 4 \\ 1 \end{Bmatrix}$

(d) $\begin{Bmatrix} 1 \\ -1 \end{Bmatrix}$ ✓

$\lambda_1 = \lambda_2 = 2, 2$

for $\lambda = 2$

$[A - 2I]X = 0$

$\begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$

$x_2 = 0 \Rightarrow x_2 = 0$

$-3x_2 = 0 \quad x_1 = \text{arbitrary}$

$X = \begin{bmatrix} \checkmark \\ 0 \end{bmatrix}$

for $\lambda = -1$

$\begin{bmatrix} 3 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$

$3x_1 + x_2 = 0$

$x_2 = -3x_1$

$\begin{bmatrix} 2 \\ -6 \end{bmatrix}, \begin{bmatrix} -1 \\ 3 \end{bmatrix}, \begin{bmatrix} -5 \\ 15 \end{bmatrix}$

Q:112 For the matrix $A = \begin{bmatrix} 3 & -2 & 2 \\ 0 & -2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$, one the eigen values is equal to - 2.

Which of the following is an eigen vector ?

(a) $\begin{bmatrix} 3 \\ -2 \\ 1 \end{bmatrix}$ (b) $\begin{bmatrix} -3 \\ 2 \\ -1 \end{bmatrix}$

(c) $\begin{bmatrix} 1 \\ -2 \\ 3 \end{bmatrix}$ (d) $\begin{bmatrix} 2 \\ 5 \\ 0 \end{bmatrix}$

for $\lambda = -2$

$[A - (-2)I]X = 0$

$$\begin{bmatrix} 5 & -2 & 2 \\ 0 & 0 & 1 \\ 0 & 0 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$$

$5x_1 - 2x_2 + 2x_3 = 0$

$x_3 = 0 \rightarrow x_3 = 0$

$3x_3 = 0$

$5x_1 = 2x_2$

Q: 113 An eigenvector of $P = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 2 & 2 \\ 0 & 0 & 3 \end{bmatrix}_{3\times 3}$ is -

(a) $[-1 \quad 1 \quad 1]^T$

(b) $[1 \quad 2 \quad 1]^T$

(c) $[1 \quad -1 \quad 2]^T$

(d) $[2 \quad 1 \quad -1]^T$

$\begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}$ for $\lambda = 1$

$[A - I]X = 0$

$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 2 \\ 0 & 0 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$

$x_3 = 0$

for $\lambda = 2$

$\begin{bmatrix} -1 & 1 & 0 \\ 0 & 0 & 2 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$

$x_3 = 0$

for $\lambda = 3$

$\begin{bmatrix} -2 & 1 & 0 \\ 0 & -1 & 2 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$

$-2x_1 + x_2 = 0 \Rightarrow x_2 = 2x_1$

$-x_2 + 2x_3 = 0 \Rightarrow x_2 = 2x_3$

Q:114 . One pair of eigen vectors corresponding to the two eigen values of the matrix $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ is -

(a) $\begin{bmatrix} 1 \\ -j \end{bmatrix}, \begin{bmatrix} j \\ -1 \end{bmatrix}$

(b) $\begin{bmatrix} 0 \\ 1 \end{bmatrix}, \begin{bmatrix} -1 \\ 0 \end{bmatrix}$

(c) $\begin{bmatrix} 1 \\ j \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

(d) $\begin{bmatrix} 1 \\ j \end{bmatrix}, \begin{bmatrix} j \\ 1 \end{bmatrix}$

$\lambda = i$ $\lambda = -i$ 2×2

$|A - \lambda I| = 0$

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

$\lambda^2 + 1 = 0$

$\lambda = \pm i$

MSQ

for $\lambda = i$

$[A - iI]X = 0$

$\begin{bmatrix} -i & -1 \\ 1 & -i \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$

$-ix_1 - x_2 = 0 \Rightarrow x_2 = -ix_1 \Rightarrow x_1 = \frac{x_2}{-i} = ix_2$

$x_1 - ix_2 = 0 \Rightarrow x_1 = ix_2$

for $\alpha = -i$

$$[A + iI]X = 0$$

$$\begin{bmatrix} i & -1 \\ 1 & i \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$$

$$ix_1 - x_2 = 0 \Rightarrow x_2 = ix_1$$

$$x_1 + ix_2 = 0 \Rightarrow x_2 = -\frac{x_1}{i} = ix_1$$

Q:115 . Given the matrix $\begin{bmatrix} -4 & 2 \\ 4 & 3 \end{bmatrix}_{2\times 2}$, the eigenvector is -

(a) $\begin{bmatrix} 3 \\ 2 \end{bmatrix}$

(b) $\begin{bmatrix} 4 \\ 3 \end{bmatrix}$

(c) $\begin{bmatrix} 2 \\ -1 \end{bmatrix}$

(d) $\begin{bmatrix} -1 \\ 2 \end{bmatrix}$

$\lambda_1+\lambda_2=-1$ $\quad -5, 4$

$\lambda_1 \times \lambda_2 = -20$

for $\lambda=-5$

$$\begin{bmatrix} 1 & 2 \\ 4 & 8 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}=0$$

$x_1+2x_2=0$

$4x_1+8x_2=0$ $\Rightarrow x_1=-2x_2$

for $\lambda=4$

$$\begin{bmatrix} -8 & 2 \\ 4 & -1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}=0$$

$-8x_1+2x_2=0 \Rightarrow x_2=4x_1$

$4x_1-x_2=0 \Rightarrow x_2=4x_1$

Q:116 For the matrix $\begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$ the eigenvalue corresponding to the eigenvector $\begin{bmatrix} 101 \\ 101 \end{bmatrix}$ is -

(a) 2

(b) 4

(c) 6

(d) 8

$$[A - \lambda I]X = 0$$

$$\begin{bmatrix} 4-\lambda & 2 \\ 2 & 4-\lambda \end{bmatrix} \begin{bmatrix} 101 \\ 101 \end{bmatrix} = 0$$

$$404 - 101\lambda + 202 = 0$$

$$101\lambda = 606 \Rightarrow \lambda = 6$$

Q:117 The value of p such that the vector $\begin{bmatrix}1\\2\\3\end{bmatrix}$ is an eigenvector of the matrix $A=\begin{bmatrix}4 & 1 & 2\\ p & 2 & 1\\ 14 & -4 & 10\end{bmatrix}$ is

$$[A-\lambda I]X=0$$

$$\begin{bmatrix}4-\lambda & 1 & 2\\ p & 2-\lambda & 1\\ 14 & -4 & 10-\lambda\end{bmatrix}\begin{bmatrix}1\\2\\3\end{bmatrix}=0$$

$4-\lambda+2+6=0$

$\lambda=12$

$p+4-2\lambda+3=0$

$p+7-24=0$

$\boxed{p=17}$ Ans

Q:118 For the matrix $A = \begin{bmatrix} 5 & 3 \\ 1 & 3 \end{bmatrix}$, ONE of the normalized eigen vector is given as -

(a) $\begin{pmatrix} \frac{1}{2} \\ \frac{\sqrt{3}}{2} \end{pmatrix}$

(b) $\begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} \end{pmatrix}$

(c) $\begin{pmatrix} \frac{3}{\sqrt{10}} \\ \frac{-1}{\sqrt{10}} \end{pmatrix}$

(d) $\begin{pmatrix} \frac{1}{\sqrt{5}} \\ \frac{2}{\sqrt{5}} \end{pmatrix}$

Q:119 One of the eigenvectors of matrix $\begin{bmatrix} -5 & 2 \\ -9 & 6 \end{bmatrix}$ is -

(a) $\begin{Bmatrix} -1 \\ 1 \end{Bmatrix}$

(b) $\begin{Bmatrix} -2 \\ 9 \end{Bmatrix}$

(c) $\begin{Bmatrix} 2 \\ -1 \end{Bmatrix}$

(d) $\begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$

Q:120 A matrix has eigenvalues – 1 and - 2. The corresponding eigen vectors are $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$ and $\begin{bmatrix} 1 \\ -2 \end{bmatrix}$ respectively. The matrix is -

(a) $\begin{bmatrix} 1 & 1 \\ -1 & -2 \end{bmatrix}$

(b) $\begin{bmatrix} 1 & 2 \\ -2 & -4 \end{bmatrix}$

(c) $\begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix}$

(d) $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

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GATE 2024-25	STEEL STRUCTURE	6.00 PM	REHAN SIR
GATE 2024-25	ENVIRONMENT	8:00 PM	PRATIK SIR
GATE 2024-25	SOM	9:00 PM	MUKESH SIR

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ALL PSUs	THERMODYNAMICS	3:00 PM	KANISTH SIR
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