Step-1

If P is a matrix, λ is the eigen value and x is the respective eigen vector, then we have $Px = \lambda x$

In view of this, we consider (1) $P = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$

We consider the characteristic equation of this matrix $|P - \lambda I| = 0$

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

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

$$\Rightarrow -\lambda^3 + 1 = 0$$

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

$$\Rightarrow \lambda = 1 \text{ and } \lambda^2 + \lambda + 1 = 0$$

$$\lambda = \frac{-1 \pm \sqrt{1-4}}{2}$$

$$\frac{-1+i\sqrt{3}}{2}, \frac{-1-i\sqrt{3}}{2}$$

$$\lambda = 1, \frac{-1+i\sqrt{3}}{2}, \frac{-1-i\sqrt{3}}{2}$$

The other eigen values are $\lambda = \frac{-1+i\sqrt{3}}{2}, \frac{-1-i\sqrt{3}}{2}$

Step-2

Similarly, we consider $(P - \lambda I) = 0$ for the matrix $P = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$

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

$$\Rightarrow -\lambda\left(-\lambda\left(1-\lambda\right)\right)-0+1\left(-1-\lambda\right)=0$$
$$\Rightarrow -\lambda\left(-\lambda+\lambda^2\right)-1+\lambda=0$$
$$\Rightarrow \lambda^2-\lambda^3-1+\lambda=0$$
$$\Rightarrow \lambda^3-\lambda^2+1=0$$
$$\Rightarrow \lambda^2\left(\lambda-1\right)-1\left(\lambda-1\right)=0$$
$$\Rightarrow \left(\lambda^2-1\right)\left(\lambda-1\right)=0$$
$$\Rightarrow \lambda=1,\lambda^2-1=0$$
$$\Rightarrow \lambda=\pm 1$$
$$\Rightarrow \lambda=1,1,-1$$

The remaining λ values are $-1,1$.