```
sigma = {{{0, 1}, {1, 0}}, {{0, -I}, {I, 0}}, {{1, 0}, {0, -1}}, {{1, 0}, {0, 1}}}
```

$\{\{\{0, 1\}, \{1, 0\}\}, \{\{0, -i\}, \{i, 0\}\}, \{\{1, 0\}, \{0, -1\}\}, \{\{1, 0\}, \{0, 1\}\}\}$

```
A = Table[ArrayFlatten[Outer[Times, sigma[[4]], sigma[[i]]]], {i, 3}]
```

$\{\{\{0, 1, 0, 0\}, \{1, 0, 0, 0\}, \{0, 0, 0, 1\}, \{0, 0, 1, 0\}\},$
$\{\{0, -i, 0, 0\}, \{i, 0, 0, 0\}, \{0, 0, 0, -i\}, \{0, 0, i, 0\}\},$
$\{\{1, 0, 0, 0\}, \{0, -1, 0, 0\}, \{0, 0, 1, 0\}, \{0, 0, 0, -1\}\}\}$

```
B = Table[ArrayFlatten[Outer[Times, sigma[[i]], sigma[[4]]]], {i, 3}]
```

$\{\{\{0, 0, 1, 0\}, \{0, 0, 0, 1\}, \{1, 0, 0, 0\}, \{0, 1, 0, 0\}\},$
$\{\{0, 0, -i, 0\}, \{0, 0, 0, -i\}, \{i, 0, 0, 0\}, \{0, i, 0, 0\}\},$
$\{\{1, 0, 0, 0\}, \{0, 1, 0, 0\}, \{0, 0, -1, 0\}, \{0, 0, 0, -1\}\}\}$

```
J = {{{0, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, -i}, {0, 0, i, 0}},
     {{0, 0, 0, 0}, {0, 0, 0, i}, {0, 0, 0, 0}, {0, -i, 0, 0}},
     {{0, 0, 0, 0}, {0, 0, -i, 0}, {0, i, 0, 0}, {0, 0, 0, 0}}};

K = I * {{{0, 1, 0, 0}, {1, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}}, {{0, 0, 1, 0}, {0, 0, 0, 0},
     {1, 0, 0, 0}, {0, 0, 0, 0}}, {{0, 0, 0, 1}, {0, 0, 0, 0}, {0, 0, 0, 0}, {1, 0, 0, 0}}};

a = J + I * K; b = J - I * K;

S = Eigenvectors[a[[3]]]
```

$\{\{1, 0, 0, 1\}, \{0, i, 1, 0\}, \{-1, 0, 0, 1\}, \{0, -i, 1, 0\}\}$

```
S.a[[1]].Inverse[S] // MatrixForm
S.a[[2]].Inverse[S] // MatrixForm
S.a[[3]].Inverse[S] // MatrixForm
```

$$\begin{pmatrix} 0 & i & 0 & 0 \\ -i & 0 & 0 & 0 \\ 0 & 0 & 0 & i \\ 0 & 0 & -i & 0 \end{pmatrix}$$

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

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

```
S.b[[1]].Inverse[S] // MatrixForm
S.b[[2]].Inverse[S] // MatrixForm
S.b[[3]].Inverse[S] // MatrixForm
```

$$\begin{pmatrix} 0 & 0 & 0 & i \\ 0 & 0 & -i & 0 \\ 0 & i & 0 & 0 \\ -i & 0 & 0 & 0 \end{pmatrix}$$

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

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

```
A[[1]] // MatrixForm
A[[2]] // MatrixForm
A[[3]] // MatrixForm
```

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

$$\begin{pmatrix} 0 & -i & 0 & 0 \\ i & 0 & 0 & 0 \\ 0 & 0 & 0 & i \\ 0 & 0 & -i & 0 \end{pmatrix}$$

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

```
A[[1]].A[[2]] - A[[2]].A[[1]] - 2 * I * A[[3]]
```

{{0, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}}