In [32]:
```
#Ivan Wang #50414321
```

In [33]:
```
#Raphael #The School of Athens #High Renaissance
```

In [34]:
```
from resources306 import*
```

In [35]:
```
from sympy import*
init_printing()
```

In [36]:
```
A = Matrix ( [ [4,2,1] , [3,-1,1] , [0,0,0] ] )
A
```

Out[36]:
$$\begin{bmatrix} 4 & 2 & 1 \\ 3 & -1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

In [37]:
```
lamda = symbols('lamda')
```

In [38]:
```
p = A.charpoly(lamda)
p
```

Out[38]:
$$\text{PurePoly}\left(\lambda^3 - 3\lambda^2 - 10\lambda, \lambda, domain = \mathbb{Z}\right)$$

In [39]:
```
factor(p.as_expr())
```

Out[39]:
$$\lambda(\lambda - 5)(\lambda + 2)$$

In [40]:
```
A.eigenvals()
```

Out[40]:
$$\{-2 : 1,\ 0 : 1,\ 5 : 1\}$$

In [41]:
```
A.eigenvects()
```

Out[41]:
$$\left[\left(-2,\ 1,\ \left[\begin{bmatrix} -\frac{1}{3} \\ 1 \\ 0 \end{bmatrix}\right]\right), \left(0,\ 1,\ \left[\begin{bmatrix} -\frac{3}{10} \\ \frac{1}{10} \\ 1 \end{bmatrix}\right]\right), \left(5,\ 1,\ \left[\begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}\right]\right)\right]$$

In [42]:
```
B = Matrix ( [ [7,-2,1] , [0,7,1] , [0,0,0] ] )
B
```

Out[42]:
$$\begin{bmatrix} 7 & -2 & 1 \\ 0 & 7 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

In [43]:
```
lamda2 = symbols('lamda')
```

In [44]:
```
poly = B.charpoly(lamda2)
poly
```

Out[44]:
$$\text{PurePoly}\left(\lambda^3 - 14\lambda^2 + 49\lambda, \lambda, domain = \mathbb{Z}\right)$$

In [45]:
```
factor(poly.as_expr())
```
Out[45]: $\lambda(\lambda-7)^2$

In [46]:
```
B.eigenvals()
```
Out[46]: $\{0:1,\ 7:2\}$

In [47]:
```
B.eigenvects()
```
Out[47]: $$\left[\left(0,\ 1,\ \left[\left[\begin{matrix}-\frac{9}{49}\\-\frac{1}{7}\\1\end{matrix}\right]\right]\right),\ \left(7,\ 2,\ \left[\left[\begin{matrix}1\\0\\0\end{matrix}\right]\right]\right)\right]$$

In [48]:
```
CoreyJR = Matrix ( [ [6,-17,1] , [8,-6,1] , [0,0,0] ] )
CoreyJR
```
Out[48]: $$\left[\begin{matrix}6 & -17 & 1\\8 & -6 & 1\\0 & 0 & 0\end{matrix}\right]$$

In [49]:
```
lamda3 = symbols('lamda')
```

In [50]:
```
polys = CoreyJR.charpoly(lamda3)
polys
```
Out[50]: $\operatorname{PurePoly}\left(\lambda^3+100\lambda,\ \lambda,\ domain=\mathbb{Z}\right)$

In [51]:
```
factor(polys.as_expr())
```
Out[51]: $\lambda\left(\lambda^2+100\right)$

In [52]:
```
CoreyJR.eigenvals()
```
Out[52]: $\{0:1,\ -10i:1,\ 10i:1\}$

In [53]:
```
CoreyJR.eigenvects()
```
Out[53]: $$\left[\left(0,\ 1,\ \left[\left[\begin{matrix}-\frac{11}{100}\\\frac{1}{50}\\1\end{matrix}\right]\right]\right),\ \left(-10i,\ 1,\ \left[\left[\begin{matrix}\frac{3}{4}-\frac{5i}{4}\\1\\0\end{matrix}\right]\right]\right),\ \left(10i,\ 1,\ \left[\left[\begin{matrix}\frac{3}{4}+\frac{5i}{4}\\1\\0\end{matrix}\right]\right]\right)\right]$$

In [54]:
```
C  = Matrix ( [ [-(1+1), 1, 0] , [1, -(1+1), 1] , [0, 1 , -(1+1)] ] )
C
```
Out[54]: $$\left[\begin{matrix}-2 & 1 & 0\\1 & -2 & 1\\0 & 1 & -2\end{matrix}\right]$$

In [55]:
```
C.eigenvals()
```

Out[55]: $\left\{-2 : 1, \ -2-\sqrt{2} : 1, \ -2+\sqrt{2} : 1\right\}$

In [56]:
```
C.eigenvects()
```

Out[56]:
$$\left[\left(-2, \ 1, \ \left[\left[\begin{matrix}-1\\0\\1\end{matrix}\right]\right]\right), \ \left(-2-\sqrt{2}, \ 1, \ \left[\left[\begin{matrix}1\\-\sqrt{2}\\1\end{matrix}\right]\right]\right), \ \left(-2+\sqrt{2}, \ 1, \ \left[\left[\begin{matrix}1\\\sqrt{2}\\1\end{matrix}\right]\right]\right)\right]$$

In [61]:
```
x1 = -2
x1
```

Out[61]: -2

In [62]:
```
x2 = -2 + sqrt(2)
x2
```

Out[62]: $-2+\sqrt{2}$

In [63]:
```
x3 = -2 - sqrt(2)
x3
```

Out[63]: $-2-\sqrt{2}$