

In[1]:= **A = {{2, 1, 1, 1}, {-1, 0, 1, 0}, {0, 0, 2, 2}, {0, 0, 1, 3}}; MatrixForm[A]**

Out[1]/MatrixForm=

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

In[2]:= **(* wielomian charakterystyczny *)**
chi = Det [A - t IdentityMatrix [4]]
Factor [chi]

Out[2]= $4 - 13 t + 15 t^2 - 7 t^3 + t^4$

Out[3]= $(-4 + t) (-1 + t)^3$

In[4]:= **B4 = A - 4 IdentityMatrix [4]; MatrixForm [B4]**

Out[4]/MatrixForm=

$$\begin{pmatrix} -2 & 1 & 1 & 1 \\ -1 & -4 & 1 & 0 \\ 0 & 0 & -2 & 2 \\ 0 & 0 & 1 & -1 \end{pmatrix}$$

In[5]:= **K4 = NullSpace [B4] (* jadro A-4I *)**

Out[5]= $\{\{1, 0, 1, 1\}\}$

In[6]:= **v1 = K4 [[1]]**

Out[6]= $\{1, 0, 1, 1\}$

In[7]:= **(* jadro A-I *)**

B1 = A - IdentityMatrix [4]; MatrixForm [B1]
NullSpace [B1]

Out[7]/MatrixForm=

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

Out[8]= $\{\{-1, 1, 0, 0\}\}$

In[9]:= **(* jadro (A-I)^2 *)**

MatrixForm [B1.B1]
NullSpace [B1.B1]

Out[9]/MatrixForm=

$$\begin{pmatrix} 0 & 0 & 4 & 5 \\ 0 & 0 & -1 & 1 \\ 0 & 0 & 3 & 6 \\ 0 & 0 & 3 & 6 \end{pmatrix}$$

Out[10]= $\{\{0, 1, 0, 0\}, \{1, 0, 0, 0\}\}$

In[11]:= **(* jadro (A-I)^3 *)**

MatrixForm [B1.B1.B1]
K3 = NullSpace [B1.B1.B1]

Out[11]/MatrixForm=

$$\begin{pmatrix} 0 & 0 & 9 & 18 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 9 & 18 \\ 0 & 0 & 9 & 18 \end{pmatrix}$$

Out[12]= $\{\{0, 0, -2, 1\}, \{0, 1, 0, 0\}, \{1, 0, 0, 0\}\}$

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In[13]:= (* lancuszek *)  
w3 = K3[[1]]  
w2 = B1.w3  
w1 = B1.w2  
B1.w1
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Out[13]= {0, 0, -2, 1}
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Out[14]= {-1, -2, 0, 0}
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Out[15]= {-3, 3, 0, 0}
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Out[16]= {0, 0, 0, 0}
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In[19]:= (* macierz przejścia z bazy Jordana do standardowej *)  
J = Transpose[{v1, w1, w2, w3}]; MatrixForm[J]
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Out[19]/MatrixForm=
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$$\begin{pmatrix} 1 & -3 & -1 & 0 \\ 0 & 3 & -2 & 0 \\ 1 & 0 & 0 & -2 \\ 1 & 0 & 0 & 1 \end{pmatrix}$$

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In[20]:= (* postac Jordana *)  
MatrixForm[Inverse[J].A.J]
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Out[20]/MatrixForm=
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$$\begin{pmatrix} 4 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$