

```
Out[6]= { {1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1}}
```

In[7]:=

Z13 = KroneckerProduct[Id, Z, Id, Z]

Out[7]= { {1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0} }

In[8]:= **Z03 = KroneckerProduct[Z, Id, Id, Z]**

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

In[9]:= **Z12 = KroneckerProduct[Id, Z, Z, Id]**

Out[9]= { {1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1} }

In[10]:= **Z1 = -I * A * (4 * IdentityMatrix[16] - Z23 - Z01 - Z13 - Z03) / 2**

Out[10]= { {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, -3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, -i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, -2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, -2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, -3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, -3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, -2 i A, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, -2 i A, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, -3 i A, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -3 i A, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -2 i A, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -2 i A, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -i A, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -3 i A, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}}

In[11]:= **Z2 = -I * A * (5 * IdentityMatrix[16] - Z23 - Z01 - Z13 - Z03 - Z12) / 2**

Out[11]= { {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, -3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, -2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, -3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, -3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, -4 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, -3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, -2 i A, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, -2 i A, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, -3 i A, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -4 i A, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -3 i A, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -3 i A, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -2 i A, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -3 i A, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}}

In[12]:= **Z2T = -1 Z2**

Out[12]= { {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 4 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 2 i A, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 2 i A, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 3 i A, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 4 i A, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3 i A, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3 i A, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2 i A, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3 i A, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}}

```
In[13]:= U1 = MatrixExp[Z1]
```

```
Out[13]= { {1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, e-3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, e-i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, e-2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, e-2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, e-3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, e-3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, e-2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, e-2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, e-3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e-3 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e-2 i A, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e-2 i A, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e-i A, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e-3 i A, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1} }
```

[illegible]

```
Out[14]= { {1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, e^{3 i A}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, e^{i A}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, e^{2 i A}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, e^{2 i A}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, e^{3 i A}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, e^{3 i A}, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, e^{2 i A}, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, e^{2 i A}, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, e^{3 i A}, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{3 i A}, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{2 i A}, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{2 i A}, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{i A}, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{3 i A}, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1} }
```

In[15]:= **U2 = MatrixExp[Z2]**

Out[15]= $\left\{ \begin{aligned} &\{1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, e^{-3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, e^{-2iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, e^{-3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, e^{-3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, e^{-4iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, e^{-3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, e^{-2iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, e^{-2iA}, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, e^{-3iA}, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{-4iA}, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{-3iA}, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{-3iA}, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{-2iA}, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{-3iA}, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1\} \end{aligned} \right\}$

In[16]:= **U2T = Transpose[MatrixExp[Z2T]]**

Out[16]= $\left\{ \begin{aligned} &\{1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, e^{3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, e^{2iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, e^{3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, e^{3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, e^{4iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, e^{3iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, e^{2iA}, 0, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, e^{2iA}, 0, 0, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, e^{3iA}, 0, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{4iA}, 0, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{3iA}, 0, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{3iA}, 0, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{2iA}, 0, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, e^{3iA}, 0\}, \\ &\{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1\} \end{aligned} \right\}$

In[17]:= **Rx = MatrixExp[-I * B * PauliMatrix[1]]**

Out[17]= $\left\{ \left\{ \cos[B], -i \sin[B] \right\}, \left\{ -i \sin[B], \cos[B] \right\} \right\}$

```
In[18]:= X11 = MatrixExp[-I * B (KroneckerProduct[PauliMatrix[1], Id, Id, Id] )]
```

```
Out[18]= {{Cos[B], 0, 0, 0, 0, 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, Cos[B], 0, 0, 0, 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, Cos[B], 0, 0, 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, Cos[B], 0, 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, Cos[B], 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, Cos[B], 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, Cos[B], 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, Cos[B], -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{-I Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0},
{0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0},
{0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0, 0},
{0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0},
{0, 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0},
{0, 0, 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0},
{0, 0, 0, 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B]}}
```

```
In[19]:= X12 = MatrixExp[-I * B (KroneckerProduct[Id, Id, Id, PauliMatrix[1]] )]
```

```
Out[19]= {{Cos[B], -I Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{-I Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, Cos[B], -I Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, -I Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, Cos[B], -I Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, -I Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, Cos[B], -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, -I Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, Cos[B], -I Sin[B], 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, -I Sin[B], Cos[B], 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], -I Sin[B], 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -I Sin[B], Cos[B], 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], -I Sin[B], 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -I Sin[B], Cos[B]}}
```

```
In[20]:= X1 = KroneckerProduct[Id, Rx, Id, Id]
```

```
Out[20]= {{Cos[B], 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, Cos[B], 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, Cos[B], 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, Cos[B], 0, 0, 0, -I Sin[B], 0, 0, 0, 0, 0, 0, 0},
{-I Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, -I Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, -I Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, -I Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, -I Sin[B], 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, -I Sin[B], 0, 0, 0, Cos[B], 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, -I Sin[B], 0},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -I Sin[B], 0, 0, Cos[B]},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B]},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -I Sin[B]},
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B]}}
```

In[21]:= **X1T = Simplify[Inverse[X1]]**

Out[21]= { {Cos[B], 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, Cos[B], 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, Cos[B], 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, Cos[B], 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 { \pm Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, \pm Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, \pm Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, \pm Sin[B], 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, \pm Sin[B], 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, \pm Sin[B]},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, \pm Sin[B]},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, \pm Sin[B]},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B]}}

In[22]:= **XT11 = Transpose[{Cos[B], 0, 0, 0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},**

{0, Cos[B], 0, 0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
{0, 0, Cos[B], 0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
{0, 0, 0, Cos[B], 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, Cos[B], 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, Cos[B], 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, Cos[B], 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, Cos[B], \pm Sin[B], 0, 0, 0, 0, 0, 0},
{ \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0},
{0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0, 0},
{0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0},
{0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0},
{0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0},
{0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, Cos[B]}}

Out[22]= { {Cos[B], 0, 0, 0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 {0, Cos[B], 0, 0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 {0, 0, Cos[B], 0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 {0, 0, 0, Cos[B], 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, Cos[B], 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, Cos[B], 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, Cos[B], 0, \pm Sin[B], 0, 0, 0, 0, 0, 0},
 { \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0, 0, 0},
 {0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0, 0},
 {0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0, 0, 0},
 {0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0, 0},
 {0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, Cos[B], 0},
 {0, 0, 0, 0, 0, \pm Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, Cos[B]}}

```
In[23]:= XT12 = Transpose[{{Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {{ $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B],  $\pm$  Sin[B]},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,  $\pm$  Sin[B], Cos[B]}}]
```

```
Out[23]= {{Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {{ $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, Cos[B],  $\pm$  Sin[B], 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0,  $\pm$  Sin[B], Cos[B], 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, Cos[B],  $\pm$  Sin[B]},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0,  $\pm$  Sin[B], Cos[B]}}
```

```
In[24]:=
```

```
In[25]:=
```

```
Ham1 = (IdentityMatrix[16] - Z03) / 2
```

```
Out[25]= {{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}}
```



```
In[26]:= Ham2 = (IdentityMatrix[16] - Z13) / 2
```

```
Out[26]= { {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0},
  {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0} }
```

```
In[27]:= Mat = U2.X11.X12.Ham1.XT12.XT11.U2T;
```

```
In[28]:= Mat2 = U2.X1.X12.Ham2.XT12.X1T.U2T;
```

```
In[29]:= H = HadamardMatrix[16];
```

```
In[30]:= UP = { {1}, {0} }
```

Out[30]= $\{\{1\}, \{0\}\}$

```
In[31]:= PM = H.KroneckerProduct[UP, UP, UP, UP]
```

[illegible]

In[32]:= **Result = Transpose[PM].Mat.PM**

$$\begin{aligned} \text{Out[32]} = & \left\{ \left\{ \frac{1}{2} \left(\frac{1}{2} \cos[B]^2 \sin[B]^2 + \frac{1}{2} e^{-3iA} \cos[B]^2 \sin[B]^2 + \right. \right. \\ & \frac{1}{4} \left(i e^{-2iA} \cos[B]^3 \sin[B] - i e^{-2iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \frac{1}{4} \left(i e^{-3iA} \cos[B]^3 \sin[B] - i e^{-3iA} \cos[B] \sin[B]^3 \right) \right) + \\ & \frac{1}{2} \left(\frac{1}{2} \cos[B]^2 \sin[B]^2 + \frac{1}{2} e^{3iA} \cos[B]^2 \sin[B]^2 + \right. \\ & \frac{1}{4} e^{3iA} \left(i e^{-2iA} \cos[B]^3 \sin[B] - i e^{-2iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \frac{1}{4} e^{3iA} \left(i e^{-3iA} \cos[B]^3 \sin[B] - i e^{-3iA} \cos[B] \sin[B]^3 \right) \right) + \\ & \frac{1}{2} \left(\frac{1}{2} \cos[B]^2 \sin[B]^2 + \frac{1}{2} e^{-iA} \cos[B]^2 \sin[B]^2 + \right. \\ & \frac{1}{4} e^{2iA} \left(i e^{-3iA} \cos[B]^3 \sin[B] - i e^{-3iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \frac{1}{4} e^{2iA} \left(i e^{-4iA} \cos[B]^3 \sin[B] - i e^{-4iA} \cos[B] \sin[B]^3 \right) \right) + \\ & \frac{1}{2} \left(\frac{1}{2} \cos[B]^2 \sin[B]^2 + \frac{1}{2} e^{iA} \cos[B]^2 \sin[B]^2 + \right. \\ & \frac{1}{4} e^{3iA} \left(i e^{-3iA} \cos[B]^3 \sin[B] - i e^{-3iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \frac{1}{4} e^{3iA} \left(i e^{-4iA} \cos[B]^3 \sin[B] - i e^{-4iA} \cos[B] \sin[B]^3 \right) \right) + \\ & \frac{1}{2} \left(-\frac{1}{2} e^{-iA} \cos[B]^2 \sin[B]^2 + \frac{1}{4} e^{2iA} \left(-i \cos[B]^3 \sin[B] + i \cos[B] \sin[B]^3 \right) + \right. \\ & \frac{1}{4} e^{2iA} \left(-i e^{-3iA} \cos[B]^3 \sin[B] + i e^{-3iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \frac{1}{4} e^{2iA} \left(e^{-2iA} \cos[B]^4 + e^{-2iA} \sin[B]^4 \right) \right) + \\ & \frac{1}{2} \left(-\frac{1}{2} e^{iA} \cos[B]^2 \sin[B]^2 + \frac{1}{4} e^{3iA} \left(-i \cos[B]^3 \sin[B] + i \cos[B] \sin[B]^3 \right) + \right. \\ & \frac{1}{4} e^{3iA} \left(-i e^{-3iA} \cos[B]^3 \sin[B] + i e^{-3iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \frac{1}{4} e^{3iA} \left(e^{-3iA} \cos[B]^4 + e^{-3iA} \sin[B]^4 \right) \right) + \\ & \frac{1}{2} \left(-\frac{1}{2} e^{-iA} \cos[B]^2 \sin[B]^2 + \frac{1}{4} e^{3iA} \left(-i e^{-2iA} \cos[B]^3 \sin[B] + i e^{-2iA} \cos[B] \sin[B]^3 \right) + \right. \\ & \frac{1}{4} e^{3iA} \left(-i e^{-3iA} \cos[B]^3 \sin[B] + i e^{-3iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \frac{1}{4} e^{3iA} \left(e^{-3iA} \cos[B]^4 + e^{-3iA} \sin[B]^4 \right) \right) + \\ & \frac{1}{2} \left(-\frac{1}{2} e^{iA} \cos[B]^2 \sin[B]^2 + \frac{1}{4} e^{4iA} \left(-i e^{-2iA} \cos[B]^3 \sin[B] + i e^{-2iA} \cos[B] \sin[B]^3 \right) + \right. \\ & \frac{1}{4} e^{4iA} \left(-i e^{-3iA} \cos[B]^3 \sin[B] + i e^{-3iA} \cos[B] \sin[B]^3 \right) + \\ & \left. \left. \frac{1}{4} e^{4iA} \left(e^{-4iA} \cos[B]^4 + e^{-4iA} \sin[B]^4 \right) \right) \right\} \right\} \end{aligned}$$

In[33]:= **Simplify[Result]**

$$\text{Out[33]} = \left\{ \left\{ \frac{1}{32} e^{-3 i A} \left(1 - e^{2 i A} + 16 e^{3 i A} - e^{4 i A} + e^{6 i A} - \right. \right. \right. \\ \left. \left. \left. (-1 + e^{2 i A})^2 (1 + e^{2 i A}) \cos[4 B] - i (1 + e^{i A})^3 (-1 + e^{i A} - e^{2 i A} + e^{3 i A}) \sin[4 B] \right) \right\} \right\}$$

In[34]:= **Fa = Simplify** $\left[\frac{1}{32} (\cos[3 A] - i \sin[3 A]) (1 - \cos[2 A] - i \sin[2 A] + \right.$
 $16 (\cos[3 A] + i \sin[3 A]) - (\cos[4 A] + i \sin[4 A]) + \cos[6 A] + i \sin[6 A] -$
 $(-1 + \cos[2 A] + i \sin[2 A])^2 (1 + \cos[2 A] + i \sin[2 A]) \cos[4 B] - i (1 + e^{i A})^3$
 $\left. (-1 + \cos[A] + i \sin[A] - (\cos[2 A] + i \sin[2 A]) + \cos[3 A] + i \sin[3 A]) \sin[4 B] \right]$

$$\text{Out[34]} = \frac{1}{16} (8 - \cos[A] + \cos[3 A] + \cos[A - 4 B] + \cos[2 (A - 2 B)] - \cos[2 (A + 2 B)] - \cos[3 A + 4 B])$$

In[35]:= **Result2 = Transpose[PM].Mat2.PM**

$$\text{Out[35]} = \left\{ \left\{ \frac{1}{4} e^{3 i A} (-i \cos[B]^3 \sin[B] + i \cos[B] \sin[B]^3) + \right. \right. \\ \frac{1}{2} e^{3 i A} (-i e^{-2 i A} \cos[B]^3 \sin[B] + i e^{-2 i A} \cos[B] \sin[B]^3) + \\ \frac{1}{2} e^{2 i A} (i e^{-3 i A} \cos[B]^3 \sin[B] - i e^{-3 i A} \cos[B] \sin[B]^3) + \\ \frac{1}{4} e^{3 i A} (-i e^{-4 i A} \cos[B]^3 \sin[B] + i e^{-4 i A} \cos[B] \sin[B]^3) + \\ \frac{1}{2} e^{3 i A} (e^{-3 i A} \cos[B]^4 + e^{-3 i A} \sin[B]^4) + \frac{1}{2} \left(\frac{1}{2} \cos[B]^2 \sin[B]^2 + \frac{1}{2} e^{-4 i A} \cos[B]^2 \sin[B]^2 + \right. \\ \frac{1}{2} (i e^{-3 i A} \cos[B]^3 \sin[B] - i e^{-3 i A} \cos[B] \sin[B]^3) \left. \right) + \frac{1}{2} \left(\frac{1}{2} \cos[B]^2 \sin[B]^2 + \right. \\ \left. \frac{1}{2} e^{4 i A} \cos[B]^2 \sin[B]^2 + \frac{1}{2} e^{4 i A} (i e^{-3 i A} \cos[B]^3 \sin[B] - i e^{-3 i A} \cos[B] \sin[B]^3) \right) \left. \right\} \right\}$$

In[36]:= **Simplify[Result2]**

$$\text{Out[36]} = \left\{ \left\{ \frac{1}{32} e^{-4 i A} \right. \right. \\ \left. \left. (1 + 14 e^{4 i A} + e^{8 i A} - (-1 + e^{4 i A})^2 \cos[4 B] - 2 i e^{i A} (-1 + e^{2 i A}) (1 + e^{2 i A})^2 \sin[4 B] \right) \right\} \right\}$$

In[37]:= **Fb =**

$$\text{Simplify} \left[\frac{1}{32} (\cos[4 A] - i \sin[4 A]) (1 + 14 (\cos[4 A] + i \sin[4 A]) + \cos[8 A] + i \sin[8 A] - \right. \\ (-1 + \cos[4 A] + i \sin[4 A])^2 \cos[4 B] - 2 i (\cos[A] + i \sin[A]) \\ \left. (-1 + \cos[2 A] + i \sin[2 A]) (1 + \cos[2 A] + i \sin[2 A])^2 \sin[4 B] \right]$$

$$\text{Out[37]} = \frac{1}{32} (14 + 2 \cos[4 A] + 2 \cos[A - 4 B] + 2 \cos[3 A - 4 B] - \\ \cos[4 (A - B)] + 2 \cos[4 B] - \cos[4 (A + B)] - 2 \cos[A + 4 B] - 2 \cos[3 A + 4 B])$$

In[38]:=

In[39]:= **Simplify**[4 Fa + Fb]

$$\text{Out[39]= } \frac{1}{32} \left(78 - 8 \cos[A] + 8 \cos[3A] + 2 \cos[4A] + 10 \cos[A - 4B] + \right. \\ \left. 2 \cos[3A - 4B] + 8 \cos\left[2(A - 2B)\right] - \cos[4(A - B)] + 2 \cos[4B] - \right. \\ \left. \cos[4(A + B)] - 8 \cos\left[2(A + 2B)\right] - 2 \cos[A + 4B] - 10 \cos[3A + 4B] \right)$$