Problem 9.1

9.1.1

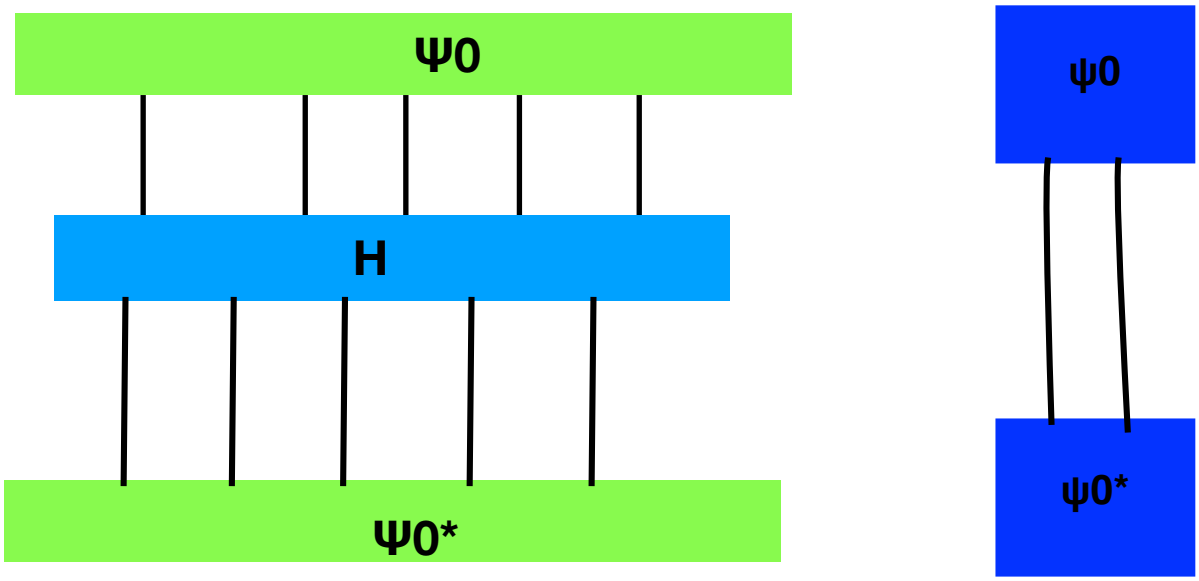
```
[[ 0.25  0.    0.    0.  ]
 [ 0.   -0.25  0.5   0.  ]
 [ 0.    0.5  -0.25  0.  ]
 [ 0.    0.    0.    0.25]]


[[[[ 0.25  0.  ]
   [ 0.    0.  ]]

  [[ 0.   -0.25]
   [ 0.5   0.  ]]]]


 [[[ 0.    0.5 ]
   [-0.25  0.  ]]

  [[ 0.    0.  ]
   [ 0.    0.25]]]]
```

9.1.2

Find eigenvector and reshape
[0. 1. 0. 0.]

```
[[0. 1.]
 [0. 0.]]
```

9.1.3



Tensor product of both ground state with hamiltonian and ground state with ground state

-0.25 1.0

9.1.4

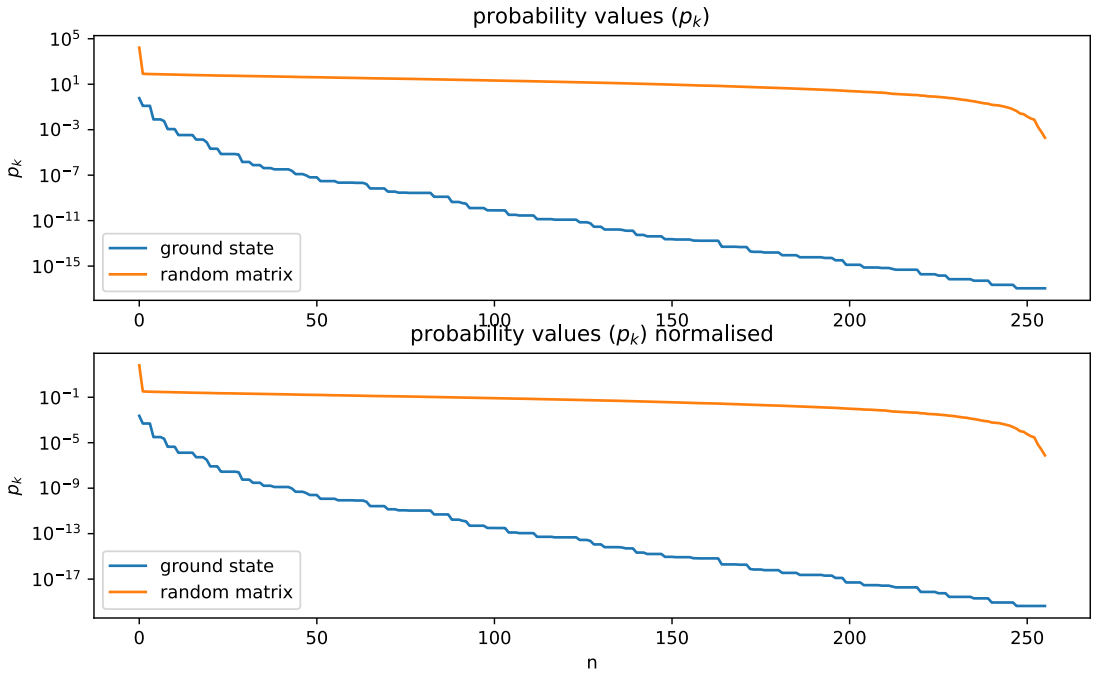
Using transposed ground state matrix
-0.25 1.0

Check if matrix is hermitian, if this is the case than H-H^T = 0
[[0.25 0.   0.   0.]
 [0.   -0.25 0.5   0.]
 [0.   0.5 -0.25 0.]
 [0.   0.   0.   0.25]]

[[0.25 0.   0.   0.]
 [0.   -0.25 0.5   0.]
 [0.   0.5 -0.25 0.]
 [0.   0.   0.   0.25]]

It can be seen that they match, and thus H is hermitian

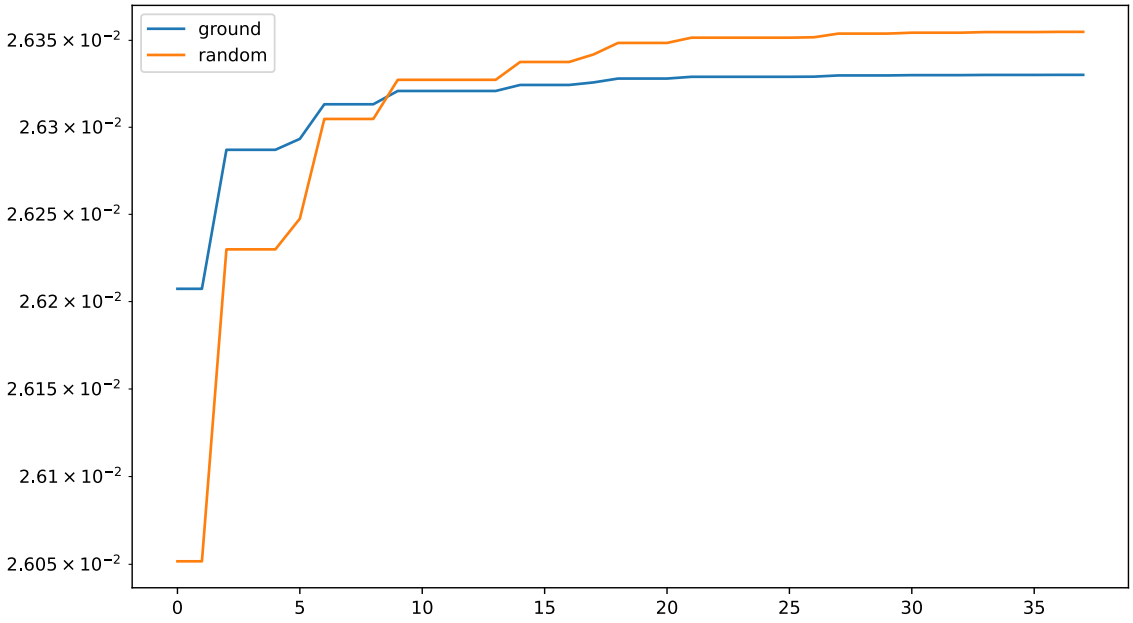
9.2.3



It can be seen that the random state has a more uniform distribution of the values for each pk, and the ground state has a higher rate of change between all pk values.

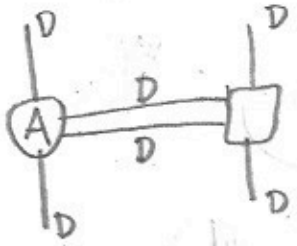
9.2.4

Energy error of ground state and the random state for the first 35 singular values, starting from the second singular value



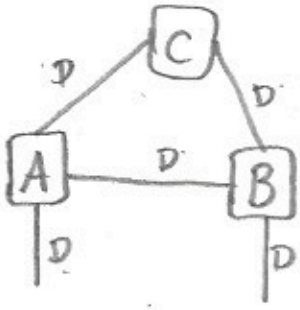
9.4

a)



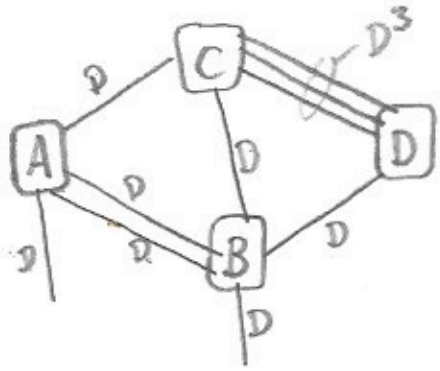
$\Rightarrow O(D^6)$

b)



$\Rightarrow O(D^5)$

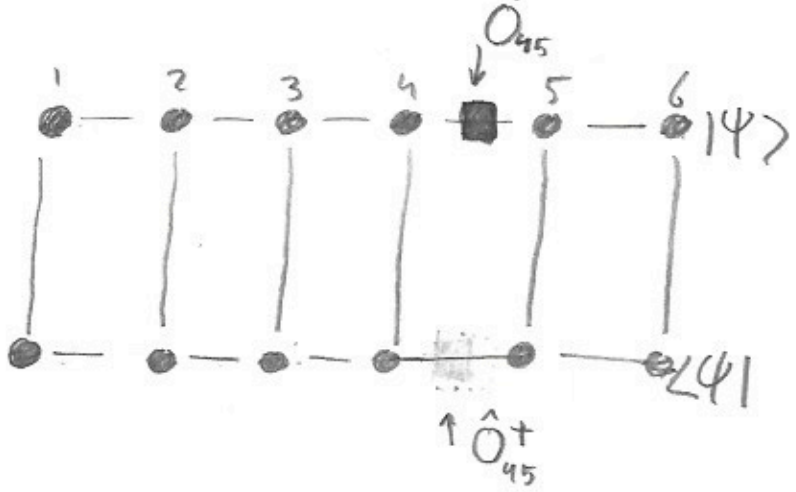
c)



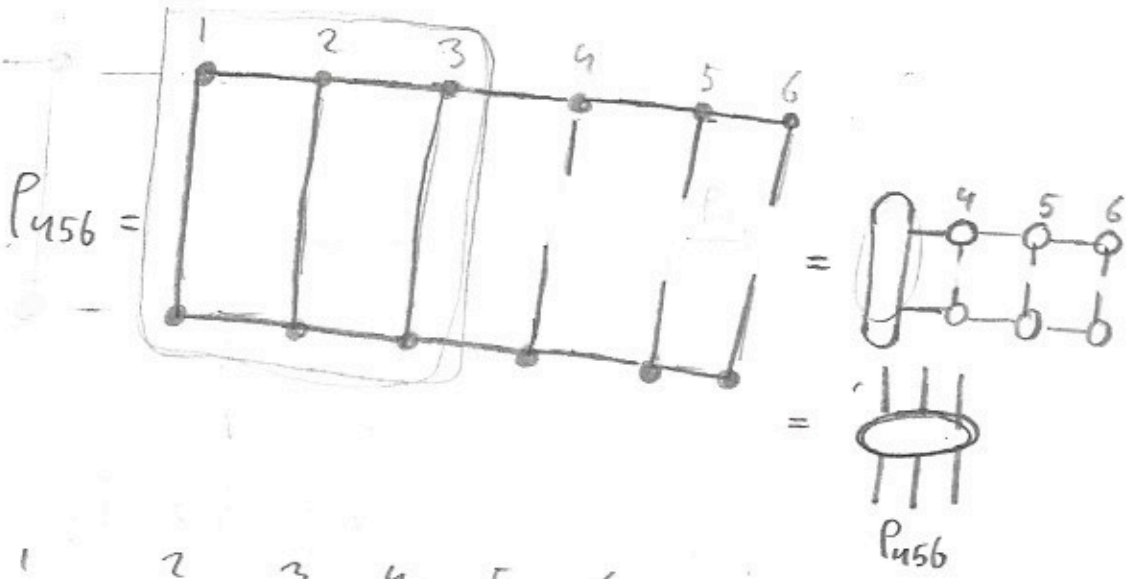
$\Rightarrow O(D^{10})$

9.5

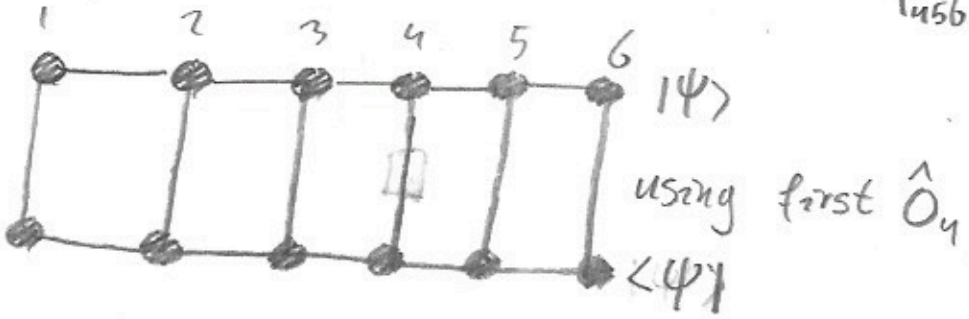
①



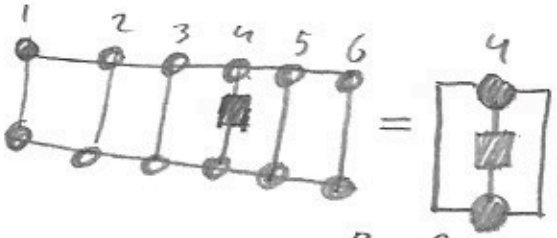
②



③



$\Rightarrow \langle\Psi|\hat{O}_4|\Psi\rangle =$



using also $\hat{O}_2 \Rightarrow \langle\Psi|\hat{O}_2\hat{O}_4|\Psi\rangle =$