

SELF TRAINING ASSESSMENT FOR QUANTUM PROGRAMMING



Quantum Programming Core is an intermediate-level course designed for individuals who want to accelerate quantum application development. This includes those in technical roles and anyone who wants to learn the basics of quantum programming using D-Wave technology.

For those who want to jump into Quantum Programming Core, we recommend having intermediate Python programming skills, comfort working with math equations and graphs, and familiarity with matrix operations.

Foundations for Quantum Programming is a beginner-level course that serves as an optional prerequisite for Quantum Programming Core. This self-paced online course provides foundational math and Python skills to help individuals gain or improve their skills before starting Quantum Programming Core.

Not sure which training is right for you?

Take the self-assessment below to help determine where to start your quantum training journey.

1. Which of the following are examples of binary variables? (Select all that apply.)

- a. The colors of the flowers in a garden
- b. The exam scores for two classmates
- c. The outcome of a coin flip
- d. The outcome of an inequality in a truth table
- e. The outcome of rolling a six-sided die
- f. The possibility of passing or failing an exam

2. Multiply and expand the following polynomial: $(2x + y)(x - 4)$ _____

3. How many elements are in the set $S = \{(1,2), (3,7), (2,8), (10,-4), (-1,5)\}$? _____

4. Evaluate the function $f(x,y) = -3x^2 + 2y - 1$ at $(-1,2)$. _____

5. Which of the following polynomials are quadratic? (Select all that apply.)

- a. $4xy + x^2 + y - 10$
- b. $xyz + y^2 + z$
- c. $(2x)/y + 5$
- d. $3xy + xz - 3yz - 10$
- e. $3x - 1$
- f. $2t^2 + 4t + 3$



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6. Expand the following summation: $\sum_{i=4}^{10} (c_i x_i)$ _____

7. For each row in the truth table, determine the values in the final column.

x	y	$1 - 2x + y - xy$
0	0	
0	1	
1	0	
1	1	

8. For each row in the truth table, determine the output in the final column.

x	y	z	$x + y + z \geq 2$
0	0	0	
0	1	0	
0	0	1	
0	1	1	
1	0	0	
1	1	0	
1	0	1	
1	1	1	

9. Assume the variable m_i represents if a machine is needed to complete a job:

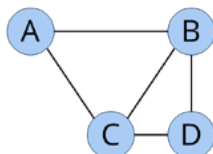
$$m_i = \begin{cases} 1 & \text{if machine } i \text{ is needed} \\ 0 & \text{if machine } i \text{ is not needed} \end{cases}$$

If machine 1 is needed to complete a job, then machine 2 is also needed to complete that same job.

What inequality represents this constraint? _____

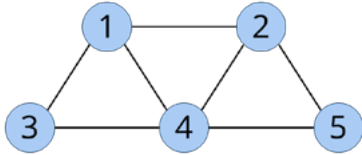
10. Assume that x and y are binary variables that take their values from 0 or 1. Reduce the exponents and simplify the following expression: $(3x - 4y)^2$ _____

11. How many vertices does the following graph have? _____





12. List all the edges for the following graph: _____



13. Which matrix is an upper triangular matrix?

a. $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 2 & 0 \\ 1 & 0 & 1 \end{pmatrix}$

b. $\begin{pmatrix} 4 & 0 & 3 \\ 0 & 5 & 2 \\ 0 & 0 & 1 \end{pmatrix}$

c. $\begin{pmatrix} 1 & 11 & 0 \\ 16 & 1 & -3 \\ -5 & 10 & 1 \end{pmatrix}$

d. $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix}$

14. What is the output for the following Python code? _____

```
import networkx as nx

G = nx.Graph()
G.add_nodes_from([2,5,7,9])
G.add_edges_from([(2, 5), (2,7), (2, 9), (5,7), (7,9)])

print(G)
```

15. When the below Python code executes, how many output lines will be printed? _____

```
def number_height(num,height):
    for i in num:
        for j in height:
            print("There are",i, j, "people")

number_height([3,10,15],["short", "tall"])
```

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16. To minimize the total cost, in dollars, of N total items you may purchase, we have the following objective function:

$$\text{totalcost} = \sum_{i=1}^N c_i y_i$$

Where N is the total number of items, c_i is the cost of item i , and y_i is a binary variable that represents whether item i was purchased or not. If $y_i=1$, item i was purchased. If $y_i=0$, item i was not purchased.

Assume:

- There are five total items ($N = 5$).
- The cost of the items are, respectively: \$3, \$20, \$5, \$30, \$10.

Write a Python program that will return the total cost of the objective function when items 1, 3, and 5 are purchased.

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Scoring Rubric:

Check your answers using the answer key below. Based on the number of questions you answered correctly, find the recommendation for your quantum training starting point.

Number of Correct Answers	Recommended Training Starting Point
0-12 out of 16	<p>We recommend starting with Foundations for Quantum Programming before you advance to the Quantum Programming Core course.</p> <p>This will enable you to build some foundational math and Python skills before advancing to Quantum Programming Core. It will also make training more enjoyable and you'll be more likely to find practical real-world applications after training concludes.</p>
13-14 out of 16	<p>While you may be able to jump straight into Quantum Programming Core, it may take you longer than average to complete the course.</p> <p>If you decide to start with Quantum Programming Core, we recommend dedicating more than 30 hours during training week and joining instructor office hours to ask questions.</p> <p>If you do not feel you can dedicate the extra time, then we recommend starting with Foundations for Quantum Programming before starting Quantum Programming Core. This will enable you to build foundational math and Python skills that will set you up for easier success in Quantum Programming Core.</p>
At least 15 out of 16	<p>You have a solid foundation of math and Python skills that will likely allow you to successfully start with Quantum Programming Core.</p>



Answer Key:

1. c, d, and f are examples of binary variables

2. $2x^2 + xy - 8x - 4y$

3. 5

4. 0

5. a, d, and f are quadratic polynomials

6. $c_4x_4 + c_5x_5 + c_6x_6 + c_7x_7 + c_8x_8 + c_9x_9 + c_{10}x_{10}$

7.

$1 - 2x + y - xy$
1
2
-1
-1

8.

$x + y - z \geq 2$
F
F
F
T
F
T
T
T

9. $m_1 \leq m_2$ or $m_1 - m_2 \leq 0$

10. $-24xy + 9x + 16y$

11. 4

12. {12, 13, 14, 24, 25, 34, 45}

13. b

14. Graph with 4 nodes and 5 edges

15. 6

16. `cost = [3, 20, 5, 30, 10] #cost`
`y = [1, 0, 1, 0, 1] #item=1 if it is bought, item=0 if is not bought`
`totalcost = 0 # set totalcost initially equal to 0`

```
totalcost = sum([cost[i]*y[i] for i in range(len(cost))])
# for i in range(len(cost)):
#     totalcost += cost[i]*y[i]

print(totalcost)
```