POLITECNICO
MILANO 1863

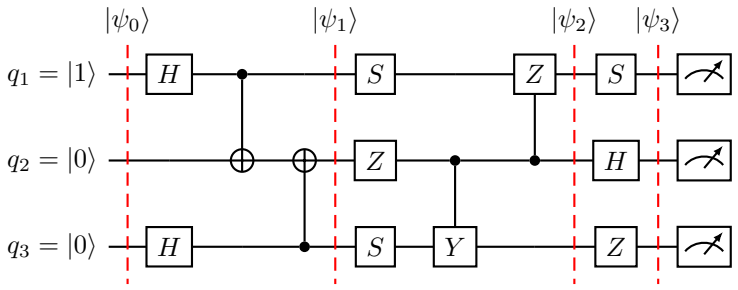
Course:	QUANTUM COMPUTING		
Professor:	P. Cremonesi M. Ferrari Dacrema	**Date:**	06/02/2025
Last Name:		**Codice Persona:**	
First Name:		**Grade:**	

Exam Rules:

- Exam duration: 2 h
- Write your answers on this exam paper by using a pen. Please do not use pencils or pens with red ink.
- You are NOT allowed to use notes, books or any other materials as well as electronic devices.
- You are NOT allowed to copy someone else's answers or let others copy from you. Those in violation of this rule will receive a failing grade and will be excluded from the next exam call.

1 Quantum Circuits (11 points)

- Consider the following quantum circuit defined on 3 qubits. Compute the probability of measuring each possible state at the end of the circuit.



The S gate is as follows:

$$S = \begin{pmatrix} 1 & 0 \\ 0 & i \end{pmatrix}$$

Important: Motivate your answer by showing all stages of the computation.

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2 Adiabatic Quantum Computing (10 points)

- Describe the Adiabatic Quantum Computing paradigm, with particular focus on the general idea and the mathematical description of the underlying physical system.

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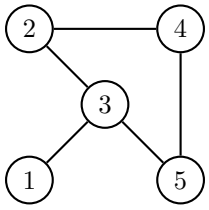
3 QUBO (10 points)

- Compute the QUBO formulation of the following SAT problem. Show its coefficient matrix in binary variables and spin variables, compute the Problem Hamiltonian and use it to identify which is the best solution.

$$\bar{x}_1 \vee x_2$$

- Compute the QUBO formulation of the Max-Cut problem related to this graph. Show its coefficient matrix in binary variables and spin variables. Draw the circuit required to solve this problem with QAOA using 1 layer.



Important: Motivate your answer by showing all stages of the computation.
