Unit 8 - Week 6 - Linear Optical approach towards Quantum Computing

Assignment-6

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-09-11, 23:59 IST.

1) For implementing quantum bits, or "qubits", using the quantum states of single photons, the polarization encoding involves: *1 point*

- the logical (0, 1) state for horizontally and vertically polarized single photons, respectively
- a horizontally polarized single photon represents a logical value 0 and a vertically polarized single photon represents a logical value 1
- a horizontally polarized single photon represents a logical value 1 and a vertically polarized single photon represents a logical value 0
- all or any one of the above

No, the answer is incorrect.
Score: 0
Accepted Answers:
all or any one of the above

2) Which of the following statements are true for implementing qubits using the quantum states of single photons using either polarization encoding or through path encoding? *1 point*

- Polarization encoded qubits are more resistant to certain kinds of experimental errors
- Polarization encoded qubits are easier to manipulate than the "path encoded" qubits
- Polarization encoded qubits are more resistant to certain kinds of experimental errors and are easier to manipulate than the "path encoded" qubits
- Polarization encoded qubits are more prone to certain kinds of experimental errors and are harder to manipulate than the "path encoded" qubits

No, the answer is incorrect.
Score: 0
Accepted Answers:
Polarization encoded qubits are more resistant to certain kinds of experimental errors and are easier to manipulate than the "path encoded" qubits

3) The development of a source of single photons cannot be accomplished by re-engineering a conventional light source. However, an isolated two-level quantum system can produce a true single-photon source through *1 point*

- stimulated emission
- absorption
- spontaneous emission
- condensation

No, the answer is incorrect.
Score: 0
Accepted Answers:
spontaneous emission

4) The important advantages of an optical approach to quantum computing lies in *1 point*

- the ability to connect logic and memory devices using optical fibers, in analogy with the use of wires in conventional electronic circuits as well as the very low interaction among photons
- the lack of the availability of the quantum logic gates needed to perform calculations
- the large number of ancilla photons needed for implementation
- its resource scalability to implementation

No, the answer is incorrect.
Score: 0
Accepted Answers:
the ability to connect logic and memory devices using optical fibers, in analogy with the use of wires in conventional electronic circuits as well as the very low interaction among photons

5) Linear optical devices could in effect be used to carry out nonlinear operations is a consequence that photons are Bosons and they stick together. Thus, near-perfect optical quantum logic gates, such as a CNOT gate, can be implemented *1 point*

- without the need for a nonlinear interaction between two single photons
- with the need for a nonlinear interaction between two single photons
- without single photons
- with multiple photons

No, the answer is incorrect.
Score: 0
Accepted Answers:
without the need for a nonlinear interaction between two single photons

6) In addition to the requirement of the conservation of total photon number, linear-optical elements in the implementation of quantum computing include: *1 point*

- beam splitter (BS)
- polarizing BS (PBS)
- half- and quarter-wave plates
- all of the above

No, the answer is incorrect.
Score: 0
Accepted Answers:
all of the above

7) In the linear optical implementation of Quantum Search Algorithm, the required Walsh-Hadamard transforms necessary for the Grover's iteration procedure is replaced by *1 point*

- the laser amplification process inside the cavity
- Optical Fourier Transforms
- Multiple round trips inside the optical cavity
- Multiple optical beam-splitting

No, the answer is incorrect.
Score: 0
Accepted Answers:
Optical Fourier Transforms

8) **Consider a *Mach-Zander interferometer* in which the beam pair spans a two-dimensional Hilbert space with orthonormal basis {|0>, |1>}. Any input to such an interferometer can be represented by the density matrix $\rho_{in} = |0\rangle\langle 0|$. We represent mirrors (*M*), beam-splitters (*B*) and relative phase shifts (*P*) by the respective unitary matrices: $U_M = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$; $U_B = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$; $U_P = \begin{pmatrix} e^{i\chi} & 0 \\ 0 & 1 \end{pmatrix}$. Which interpretation of the output density matrix of such an interferometer given by: $\rho_{out} = U_B U_M U_P U_B \rho_{in} U_B^\dagger U_P^\dagger U_M^\dagger U_B^\dagger$ is correct?** *1 point*

- $\rho_{out} = \frac{1}{2}\begin{pmatrix} 1+sin(\chi) & i\,cos(\chi) \\ -i\,cos(\chi) & 1-sin(\chi) \end{pmatrix}$ resulting in a relative phase χ in the output signal
- $\rho_{out} = \frac{1}{2}\begin{pmatrix} 1+cos(\chi) & i\,sin(\chi) \\ -i\,sin(\chi) & 1-cos(\chi) \end{pmatrix}$ resulting in a relative phase χ in the output signal
- Intensity along $|0\rangle$ as $I \propto 1 + cos(\chi)$ resulting in an absolute phase χ in the output signal
- $\rho_{out} = \begin{pmatrix} 1+cos(\chi) & i\,sin(\chi) \\ -i\,sin(\chi) & 1-cos(\chi) \end{pmatrix}$ resulting in an absolute phase χ in the output signal

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\rho_{out} = \frac{1}{2}\begin{pmatrix} 1+cos(\chi) & i\,sin(\chi) \\ -i\,sin(\chi) & 1-cos(\chi) \end{pmatrix}$ resulting in a relative phase χ in the output signal

9) Any operation possible on a quantum computer can be reduced to a set of universal quantum gates. However, this is impossible since the number of possible quantum gates is uncountable, whereas the number of finite sequences from a finite set is countable. But we only require that any quantum operation can be approximated by a sequence of gates from this finite set. Thus, one simple set of two-qubit universal quantum gates is: *0 points*

- the Hadamard gate (*H*), the phase shift gate $(\frac{\pi}{8})$, and the controlled NOT gate (CNOT)
- the Hadamard gate (*H*), the phase shift gate $(\frac{\pi}{8})$, and the controlled NOT gate (CNOT)
- the Square root NOT gate (*SRN*), the phase shift gate $(\frac{\pi}{8})$, and Hadamard gate (*H*)
- the SWAP gate, the Hadamard gate (*H*), and the controlled NOT gate (CNOT)

No, the answer is incorrect.
Score: 0
Accepted Answers:
the Hadamard gate (*H*), the phase shift gate $(\frac{\pi}{8})$, and the controlled NOT gate (CNOT)

10) In the implementation of Quantum Search Algorithm using optical system (Classical Fourier Optics inside the cavity of a laser) approach essentially maps the 2^n-dimensional Hilbert space of n-qubits by the Hilbert space of a single photon in *1 point*

- a set of 2n transverse and longitudinal modes and is not a universal quantum computer.
- an entangled set of 2n transverse modes and is a universal quantum computer.
- a superposition of 2^n transverse modes and is not a universal quantum computer.
- a superposition of 2^n longitudinal modes and is a universal quantum computer.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a superposition of 2^n transverse modes and is not a universal quantum computer.