Vocational English IV
(Mesleki Yabancı Dil IV)
Week 6

Engineering Faculty
Computeer Engineering

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INTRODUCTION

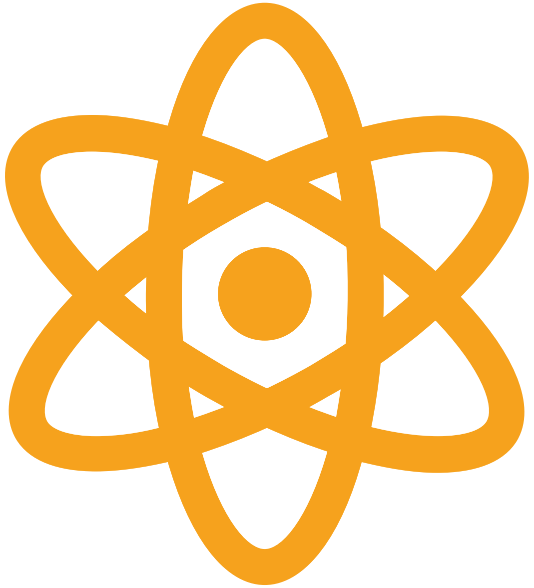
UNDERSTANDING QUANTUM COMPUTING

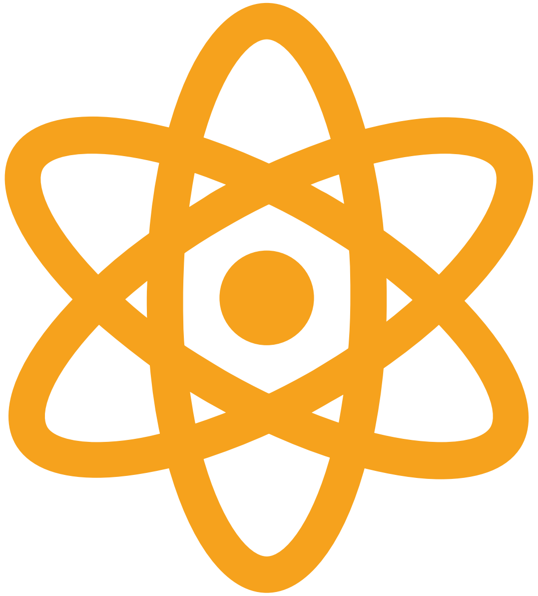
What is quantum computing?

https://www.ibm.com/think/topics/quantum-computing

WHAT IS QUANTUM COMPUTING?

- Quantum computing is an emergent field of cutting-edge computer science harnessing the unique qualities of quantum mechanics to solve problems beyond the ability of even the most powerful classical computers.





HOW FAST IS QUANTUM COMPUTING?

By taking advantage of quantum physics, fully realized quantum computers would be able to process massively complicated problems at **orders of magnitude** faster than modern machines. For a quantum computer, challenges that might take a classical computer thousands of years to complete might be reduced to a matter of minutes.

QUANTUM MECHANICS PRINCIPLES

Superposition: a state where a quantum system can represent multiple possibilities.

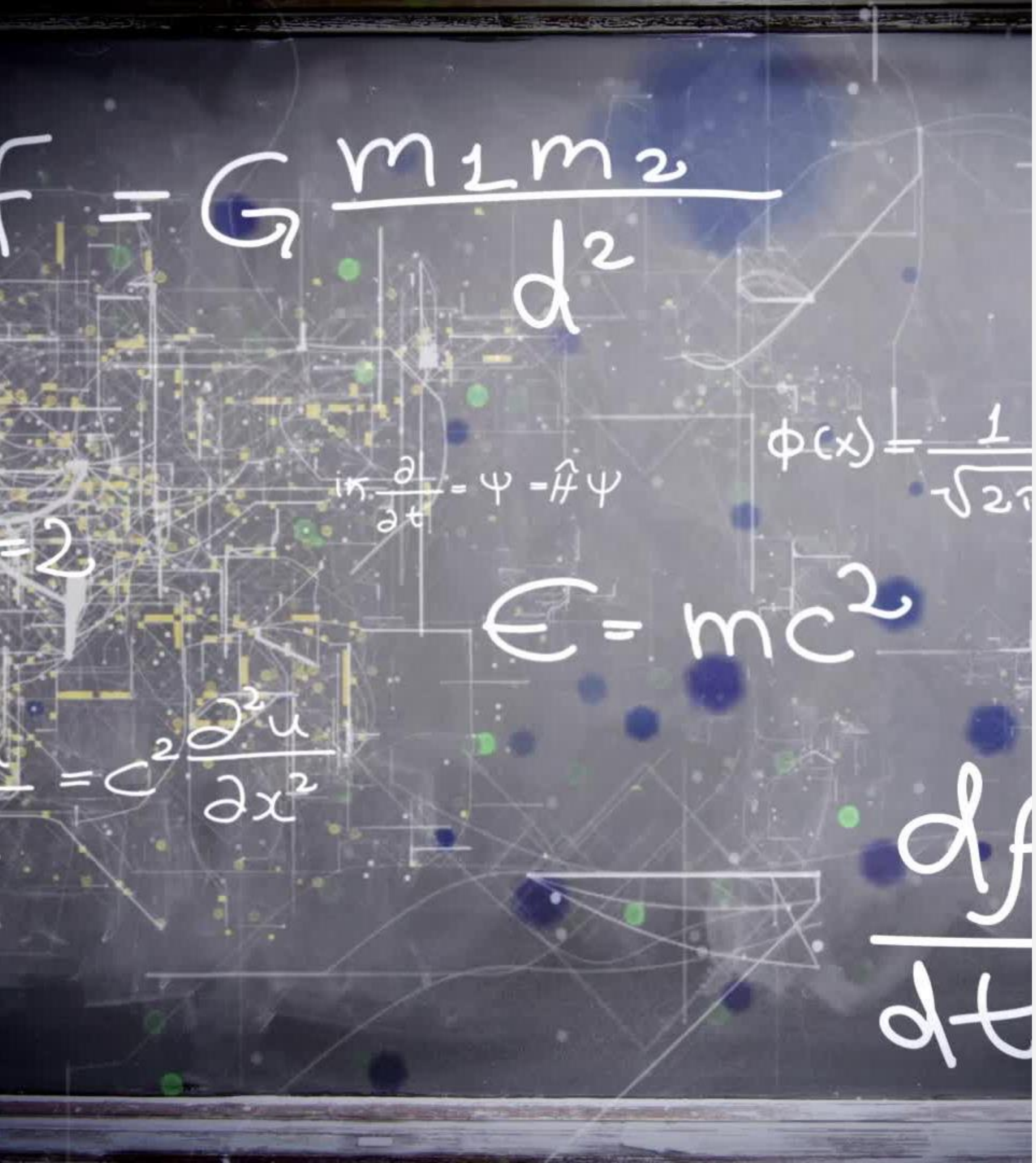
Entanglement: quantum particles become strongly correlated.

Decoherence: decay or collapse into measurable states.

Interference: entangled quantum states interact to affect outcome probabilities.

QUBITS VS. CLASSICAL BITS

- While classical computers rely on binary bits (zeros and ones), quantum computers use quantum bits, or **qubits**, in superposition.
  A qubit can behave like a bit and store either a zero or a one, but it can also be a weighted combination of zero and one at the same time.



HOW QUANTUM COMPUTERS WORK

- A quantum circuit, prepared by the user, uses operations to generate entanglement, leading to interference between these different states, as governed by an algorithm.

QUANTUM HARDWARE

Qubits are created by manipulating quantum particles, such as photons, electrons, trapped ions and atoms.

Common types: superconducting qubits, trapped ion qubits, quantum dots, photons, and neutral atoms.

CLASSICAL VS. QUANTUM COMPUTING

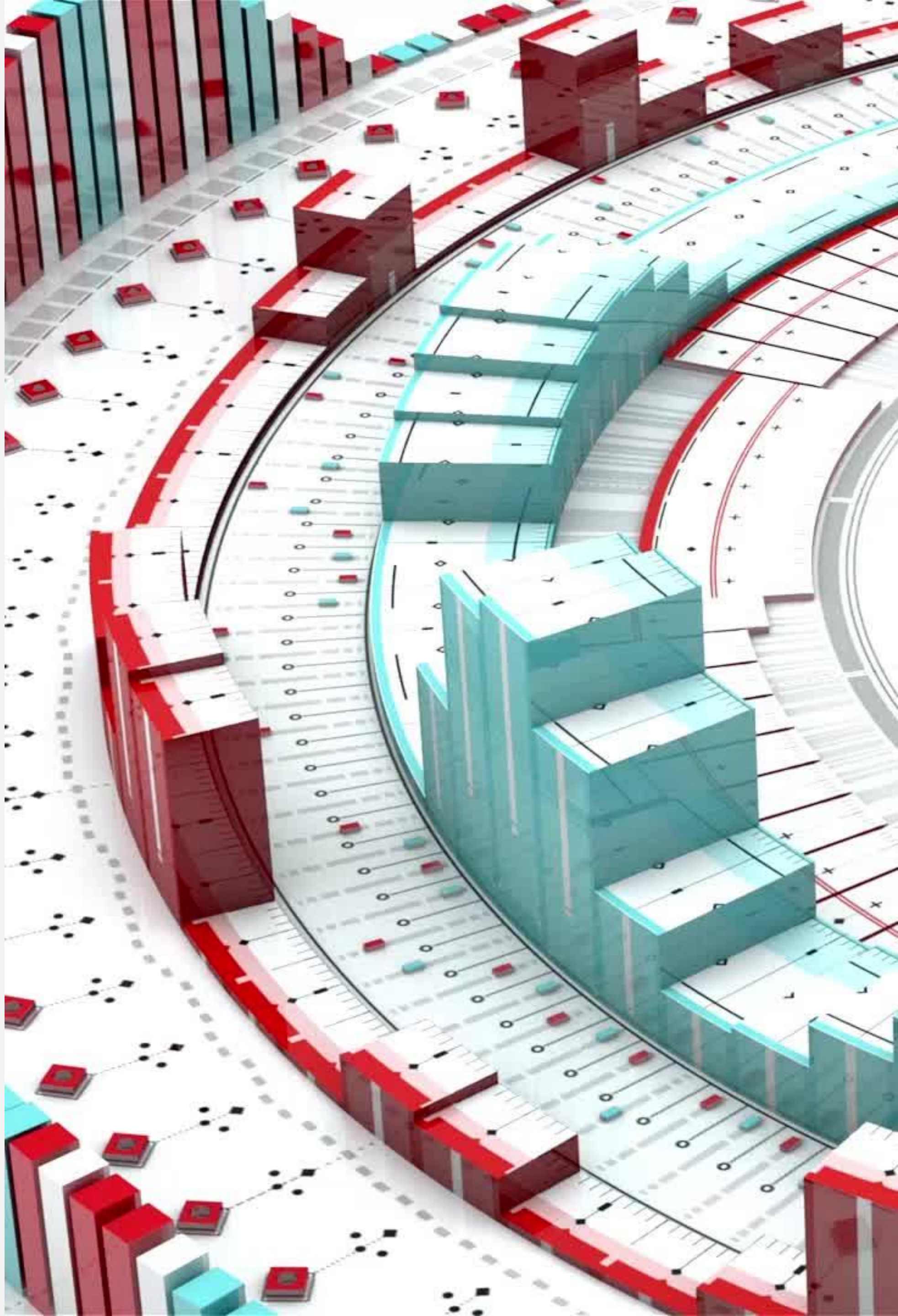
- Classical computers store information in bits (0 or 1) and process data sequentially.
- Quantum computers store information in qubits as 0, 1 or a superposition of both and process data with quantum logic at parallel instances, relying on interference.

QUANTUM USE CASES

- From the development of new drugs and performing machine learning in a new way to supply-chain optimization and climate change challenges, quantum computing might hold the key to breakthroughs in a number of critical industries.

QUANTUM UTILITY AND ADVANTAGE

- **Quantum utility**: provides accurate solutions beyond brute-force classical simulators.
- **Quantum advantage**: outperforms all classical methods for a specific problem.
  IBM uses benchmarks like **quantum volume**, **layer fidelity**, and **CLOPS** to measure progress.



LISTENING

- https://www.ibm.com/think/podcasts/mixture-of-experts/quantum-leap-model-context-protocol-coreweave-ipo-ai-voice-companion

Episode 45: Quantum leap, Model Context Protocol, CoreWeave IPO, and AI voice companion **[first 10 minutes only]**

PRESENTATION TIME!

Overall 20%

5% Introduction of self and the topic
10% Presentation content(English is favoured)
5% Presentation skills and using English

You have 5 Minutes, make it count!

WORDS OF THE WEEK

1. **Qubit** – A unit of quantum information representing 0, 1, or both simultaneously via superposition.
2. **Superposition** – A quantum state where a system exists in multiple configurations at once.
3. **Entanglement** – A phenomenon where qubits become linked so the state of one affects the other instantly, regardless of distance.
4. **Decoherence** – The process where quantum states lose coherence and become classical (measurable) states.
5. **Interference** – The interaction of quantum states where amplitudes cancel or reinforce each other, affecting outcomes.
6. **Quantum Algorithm** – A set of steps designed to run on a quantum computer, using superposition and entanglement.
7. **Quantum Gate** – The basic operation in a quantum circuit, modifying qubit states similarly to classical logic gates.
8. **Quantum Circuit** – A series of quantum gates applied to qubits to perform computations.
9. **Quantum Volume** – A performance benchmark measuring the complexity of a quantum computer's output on random circuits.
10. **Layer Fidelity** – A metric evaluating the quality and error resistance of a quantum device’s full circuit operations.
11. **CLOPS (Circuit Layer Operations per Second)** – A measure of how fast a quantum processor can execute layers of circuits.
12. **Quantum Advantage** – The point at which quantum computers outperform classical ones for certain tasks.
13. **Quantum Utility** – Achieving useful, accurate results from a quantum computer beyond what classical brute-force methods can deliver.
14. **Superconducting Qubits** – Qubits created from superconductors operating at near-zero temperatures for stability and speed.
15. **Trapped Ion Qubits** – Qubits created by trapping and controlling ions using electromagnetic fields.
16. **Quantum Dot** – A tiny semiconductor that holds and manipulates a single electron as a qubit.
17. **Photon** – A light particle used in quantum computing and secure quantum communication.
18. **Josephson Junction** – A component made from two superconductors separated by an insulator, crucial for quantum circuits.
19. **Quantum Error Correction** – Techniques used to protect quantum information from decoherence and operational faults.
20. **Qiskit** – An open-source quantum SDK by IBM for writing, optimizing, and executing quantum algorithms.

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*End of Fun/File