

Question and Answer Set for All Assignments

Assignment 1: Implementations of 16 Qubit Random Number Generator

- Q: What is a quantum random number generator (QRNG)?

A: A QRNG uses quantum mechanics—especially superposition and measurement—to produce unpredictable, true random numbers.

- Q: Why use qubits instead of classical bits for randomness?

A: Qubits exist in superposition, giving inherently unpredictable outcomes when measured.

- Q: What role does the Hadamard gate play in QRNG?

A: It places qubits in an equal superposition of $|0\rangle$ and $|1\rangle$, ensuring random results.

- Q: How many possible outputs can 16 qubits generate?

A: $2^{16} = 65,536$ unique random outcomes.

- Q: Which Python library can be used to simulate a QRNG?

A: Qiskit (IBM), Cirq (Google), or Braket SDK (AWS).

- Q: What is the purpose of measurement in a QRNG circuit?

A: Measurement collapses the quantum state into a definite binary outcome, producing randomness.

- Q: Why is quantum randomness superior to pseudorandom generation?

A: Because it's based on physical uncertainty rather than algorithmic determinism.

- Q: Mention one practical application of QRNG.

A: Cryptography, secure key generation, and simulations requiring high-quality randomness.

Assignment 2: Tackle Noise with Error Correction

- Q: What is quantum noise?

A: Unwanted disturbances like decoherence or gate errors affecting quantum states.

- Q: What is the main challenge of quantum computation?

A: Maintaining qubit coherence and minimizing noise during operations.

- Q: What is quantum error correction (QEC)?

A: A technique to detect and correct errors in quantum states using redundant encoding.

- Q: Name two types of quantum errors.

A: Bit-flip error and phase-flip error.

- Q: What is the Shor Code?

A: A 9-qubit code that corrects both bit-flip and phase-flip errors simultaneously.

- Q: What is a stabilizer code?

A: A type of QEC code that uses stabilizer operators to detect error syndromes.

- Q: Which library in Qiskit supports noise modeling?

A: Qiskit Aer and Qiskit Ignis modules.

- Q: Why is QEC essential for fault-tolerant quantum computing?

A: It ensures reliable computation despite physical imperfections of qubits.

Assignment 3: Implement Quantum Teleportation Algorithm in Python

- Q: What is quantum teleportation used for?

A: To transfer quantum states between distant qubits without physically moving them.

- Q: What physical resource enables teleportation?

A: Quantum entanglement between sender (Alice) and receiver (Bob).

- Q: Which gates are essential in the teleportation circuit?

A: Hadamard (H), CNOT, and measurement operations.

- Q: What kind of information is transmitted classically?

A: Two classical bits representing measurement results.

- Q: What does Bob do with classical bits received from Alice?

A: He applies corrective operations (X and Z gates) to reconstruct the original state.

- Q: Which Python library supports this implementation?

A: Qiskit, with the Aer simulator for execution.

- Q: What confirms successful teleportation?

A: The receiver's qubit matches the sender's original state after correction.

- Q: What is not transferred in teleportation?

A: The physical particle itself—only the state information is transmitted.

Assignment 4: The Randomized Benchmarking Protocol

- Q: What is the goal of randomized benchmarking?

A: To estimate average gate error rates in a quantum processor.

- Q: What are Clifford gates?

A: A set of gates used to create random sequences for benchmarking due to their mathematical properties.

- Q: What is the output metric of benchmarking?

A: Average gate fidelity or error per Clifford gate.

- Q: Why is it called “randomized”?

A: Because random gate sequences are applied to average out specific noise effects.

- Q: What differentiates it from quantum process tomography?

A: It's faster and less sensitive to SPAM (state preparation and measurement) errors.

- Q: Which Qiskit module helps perform benchmarking?

A: Qiskit Ignis.

- Q: What does a decay curve in benchmarking indicate?

A: The error rate as a function of sequence length.

- Q: Why is this method important for quantum hardware testing?

A: It validates real-world gate performance and helps calibrate qubits.

Assignment 5: Implementing a 5 Qubit Quantum Fourier Transform

- Q: What is the Quantum Fourier Transform (QFT)?

A: The quantum equivalent of the discrete Fourier transform (DFT) used in many quantum algorithms.

- Q: What is the main mathematical function of QFT?

A: To convert quantum states from the time domain to frequency domain.

- Q: What is the computational advantage of QFT?

A: It runs in $O(n^2)$ time compared to $O(n^n)$ for classical DFT.

- Q: Which gates are primarily used in QFT?

A: Hadamard and controlled-phase rotation gates.

- Q: Why is qubit swapping needed at the end of QFT?

A: To reverse the order of qubits, aligning them to the correct bit significance.

- Q: What is the role of phase gates in QFT?

A: They introduce relative phase shifts to encode frequency information.

- Q: What can QFT be used for?

A: Algorithms like Shor's factoring, phase estimation, and period finding.

- Q: Which simulator can execute QFT circuits?

A: Qiskit Aer or Cirq Simulator.

Assignment 6: Design User Persona for Selected Product/System

- Q: What is a user persona?

A: A fictional profile that represents a target user group.

- Q: Why is creating personas important?

A: They guide design decisions based on user needs, goals, and pain points.

- Q: What are the main components of a persona?

A: Demographics, goals, frustrations, behaviors, motivations, and quotes.

- Q: How are personas created?

A: Using user research, surveys, interviews, and analytics.

- Q: What is an empathy map?

A: A visual tool that helps understand what users think, feel, say, and do.

- Q: How many personas are ideal in a project?

A: Usually 2–4 key personas representing major user types.

- Q: What tools can be used to create personas?

A: Figma, Miro, Canva, or UXPressia.

- Q: How do personas support UX design?

A: They help prioritize features and tailor design to user expectations.

Assignment 7: Online Learning Platform – Wireframe Design

- Q: What is the purpose of wireframing?

A: To visualize page structure and functionality before final design.

- Q: What elements should an e-learning wireframe include?

A: Course list, video section, quiz area, progress tracker, and navigation.

- Q: What is the difference between low-fidelity and high-fidelity wireframes?

A: Low-fidelity focuses on layout; high-fidelity includes visuals and interactions.

- Q: Which design tool is used here?

A: Figma.

- Q: What is a dashboard in online learning platforms?

A: A personalized page showing enrolled courses, progress, and achievements.

- Q: What is the purpose of progress tracking?

A: To motivate learners by showing completion levels and milestones.

- Q: How does UX design impact learning outcomes?

A: A clear, simple interface enhances engagement and usability.

- Q: Why include quizzes in the platform?

A: To assess understanding and provide feedback to learners.

Assignment 8: Designing a Social Fitness App (Wireframes & Prototype)

- Q: What is the goal of a social fitness app?

A: To combine health tracking with social motivation and community.

- Q: What are the key features?

A: Workout logs, goals, leaderboards, social feed, and progress visualization.

- Q: What is a prototype?

A: A clickable simulation showing app flow and user interaction.

- Q: Which tool is used to create wireframes and prototypes?

A: Figma.

- Q: Why include social features?

A: They encourage consistency through peer motivation and sharing.

- Q: What are some motivational design elements?

A: Badges, achievements, progress rings, and weekly goals.

- Q: How is UI design evaluated?

A: Through usability testing and user feedback.

- Q: What colors and icons are suitable for fitness apps?

A: Energetic, vibrant colors with simple, dynamic icons.

Assignment 9: Improving the User Interface of a Fitness Tracking App (Figma)

Q: What are main principles of good UI design?

A: Clarity, simplicity, consistency, and feedback.

- Q: What are common usability issues in fitness apps?

A: Overcrowded layouts, unclear progress visuals, and complex navigation.

- Q: What are motivational UI elements?

A: Streaks, progress bars, achievement badges, and goal meters.

- Q: Why is color psychology important in UI?

A: Colors influence user emotions and motivation.

- Q: What improvements can Figma help implement?

A: Component consistency, modern typography, and interactive prototypes.

- Q: What is responsive design?

A: A design approach ensuring the app adapts to all screen sizes.

- Q: How do you visualize progress effectively?

A: With charts, timelines, or visual rings for completed goals.

- Q: What is the goal of redesigning UI?

A: To make the app more engaging, intuitive, and user-friendly.

Assignment 10: Product Packaging Mockup Design

- Q: What is a packaging mockup?

A: A visual 3D representation showing how the final product packaging will look.

- Q: Why are mockups important?

A: They allow designers and clients to visualize and refine the design before printing.

- Q: What are the key elements of packaging design?

A: Logo, typography, color scheme, product image, and information.

- Q: Which software tools are used?

A: Figma, Canva, Smartmockups, or Adobe Dimension.

- Q: What makes packaging attractive?

A: Balanced layout, clear text, and appealing visuals that reflect brand identity.

- Q: What is dieline in packaging design?

A: A 2D template showing where cuts, folds, and artwork will be placed.

- Q: Why use multiple angles in mockups?

A: To showcase the design from front, side, and top views for presentation.

- Q: What role does color play in packaging?

A: It attracts attention and communicates product tone or category.