Part 1: Theoretical Analysis (40%)

1. Essay Questions

Q1: Explain how Edge AI reduces latency and enhances privacy compared to cloud-based AI. Provide a real-world example (e.g., autonomous drones).

Edge AI reduces latency by processing data locally on the device or a nearby server, eliminating the time delay of sending data to and from a distant cloud. It enhances privacy by keeping sensitive raw data on the device, minimizing its exposure during transmission and storage in the cloud. For autonomous drones, Edge AI allows for instantaneous obstacle avoidance and navigation decisions on board, crucial for safety and real-time operation, while preventing sensitive video feeds from being continuously streamed to remote servers.

Q2: Compare Quantum AI and classical AI in solving optimization problems. What industries could benefit most from Quantum AI?

Classical AI solves optimization problems through sequential processing, heuristic searches, and approximations, often struggling with exponentially complex problems and getting stuck in local optima. Quantum AI leverages quantum phenomena like superposition and entanglement to explore vast solution spaces simultaneously, potentially finding global optima much faster for intractable problems. Industries like logistics (fleet optimization), finance (portfolio optimization), drug discovery (molecular docking), manufacturing (production scheduling), and energy (smart grid optimization) stand to benefit most from Quantum AI's ability to tackle complex optimization challenges.

Q3: Discuss the societal impact of Human-AI collaboration in healthcare. How might it transform roles like radiologists or nurses?

Human-AI collaboration in healthcare will lead to more accurate diagnoses, personalized treatments, and increased efficiency by augmenting human capabilities. It can democratize healthcare access and accelerate research. For radiologists, AI will act as a "second pair of eyes" for initial screening and anomaly detection, allowing them to focus on complex cases, interpretation, and patient communication. For nurses, AI will automate administrative tasks and provide intelligent monitoring and decision support, freeing them to prioritize empathetic patient interaction, complex care, and critical thinking.

2. Case Study Critique

Integrating Artificial Intelligence (AI) with the Internet of Things (IoT) significantly enhances urban sustainability by making cities smarter, more efficient and environmentally friendly. One major way this integration helps is through intelligent transportation and traffic management systems. IoT devices such as traffic sensors, smart cameras and GPS-enabled vehicles generate real-time data, which AI then analyzes to optimize traffic flow, reduce congestion and cut down vehicle idle times. This results in shorter travel times, lower fuel consumption and reduced emissions. Similarly, in public transportation and commercial fleets, AI uses data from IoT devices to predict maintenance needs and optimize routes, increasing efficiency while minimizing downtime and carbon footprint. Additionally, AI-powered waste collection, air quality monitoring, and energy grid optimization driven by IoT allow cities to manage resources more sustainably and respond quickly to environmental changes.

However, despite these advantages, there are significant challenges that must be addressed. One major concern is data privacy and security. AI–IoT systems collect vast amounts of sensitive data Including personal, location and surveillance information which, if improperly handled or breached, could violate individual privacy and lead to public distrust. Ensuring data encryption, anonymization, and strict access controls is crucial to maintaining public confidence.

Another challenge is the high technical complexity and infrastructure cost involved in implementing such systems. Deploying a city-wide AI–IoT network requires large investments in sensors, software, connectivity, and integration with existing urban infrastructure. Moreover, interoperability between different technologies and scalability of systems in densely populated areas are ongoing technical hurdles. Cities need careful planning, phased implementation, and often, public-private partnerships to make AI–IoT integration financially and logistically feasible.