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 processes data on local devices rather than relying on centralized cloud servers. This reduces latency by enabling real-time decision-making closer to the data source, which is crucial in time-sensitive applications like autonomous drones. It also enhances privacy because data does not have to leave the device, reducing exposure to network vulnerabilities. For example, autonomous drones can detect obstacles or people and make navigation decisions without sending sensitive visual data to the cloud.

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

Quantum AI leverages quantum computing principles, such as superposition and entanglement, to solve complex optimization problems that are computationally expensive for classical AI. While classical AI often uses heuristic approaches, Quantum AI explores multiple solutions simultaneously, leading to potentially exponential speedups. Industries like pharmaceuticals (e.g., drug discovery), logistics (e.g., route optimization), and finance (e.g., portfolio optimization) stand to benefit significantly.

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

Human-AI collaboration can transform healthcare by enhancing diagnostic accuracy and reducing workload. AI tools can assist radiologists by identifying patterns in medical images, allowing them to focus on complex cases. Nurses may benefit from AI systems that monitor patient vitals and predict deterioration. While AI enhances capabilities, it also shifts roles towards supervision and interpretation, emphasizing the importance of human judgment.

2. Case Study Critique: AI in Smart Cities

AI-IoT for Traffic Management improves urban sustainability by optimizing traffic flow, reducing congestion, and lowering emissions. Real-time data from sensors allows AI models to predict and respond to traffic patterns. However, challenges include:

- Data security: Risk of cyberattacks on critical infrastructure.

- Infrastructure cost: High initial investment for IoT and AI integration.

Part 2: Practical Implementation (50%)

Task 1: Edge AI Prototype

Tools: TensorFlow Lite, Raspberry Pi/Colab (simulation)

Goal:

- Train a lightweight image classification model (e.g., recognizing recyclable items).

- Convert the model to TensorFlow Lite and test it on a sample dataset.

Benefit: Enables real-time, on-device inference without network dependency.

Task 2: AI-Driven IoT Concept

Scenario: Design a smart agriculture system using AI and IoT.

Sensors: Soil moisture, temperature, humidity, light intensity.

AI Model: Supervised learning model (e.g., Random Forest) to predict crop yields.

Data Flow: Sensors → Microcontroller → Cloud DB → AI Model → Insights for farmers.

Task 3: Ethics in Personalized Medicine

Dataset: Cancer Genomic Atlas

AI-based treatment systems may be biased if the training data underrepresents certain ethnic groups, leading to unfair recommendations. Strategies for fairness include:

- Using diverse datasets.

- Validating across demographics.

- Engaging interdisciplinary teams.

Part 3: Futuristic Proposal (10%)

Title: AI-Powered Climate Engineering System (2030)

Problem: Global warming and extreme climate events.

AI Workflow:

- Inputs: Satellite data, weather forecasts, pollution levels.

- Model: Predictive AI + Reinforcement learning.

- Action: Suggest or activate geoengineering solutions (e.g., cloud seeding).

Risks: Overreliance on AI; unintended environmental effects.

Benefits: Scalable, real-time climate control; data-driven intervention.

Bonus Task (10%): Quantum AI Simulation

Using IBM Quantum Experience, simulate a basic quantum circuit to represent a qubit superposition. Such simulations could be used in drug discovery by rapidly evaluating molecular interactions, thereby reducing time to market and enhancing precision.

Task 1: Edge AI Prototype - Code Example

```
import tensorflow as tf
from tensorflow import keras

# Load dataset and train model
(x_train, y_train), (x_test, y_test) = keras.datasets.mnist.load_data()
x_train, x_test = x_train / 255.0, x_test / 255.0

model = keras.Sequential([
    keras.layers.Flatten(input_shape=(28, 28)),
    keras.layers.Dense(128, activation='relu'),
    keras.layers.Dense(10)
])

model.compile(optimizer='adam',
              loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])

model.fit(x_train, y_train, epochs=5)
model.evaluate(x_test, y_test, verbose=2)

# Convert to TensorFlow Lite
converter = tf.lite.TFLiteConverter.from_keras_model(model)
tflite_model = converter.convert()

# Save the model
with open('model.tflite', 'wb') as f:
    f.write(tflite_model)
```

Task 2: Smart Agriculture System - Data Flow Diagram

Below is a sample data flow diagram showing how sensor data flows to the AI model for yield prediction.