Q1: Explain the minimax loss function in GANs and how it ensures competitive training between the generator and discriminator.

The minimax loss function is the key driver in the GAN adversarial training. The discriminator objective is to maximize V(D, G) by outputting high probabilities for real data and low probabilities for fake data, while the generator attempts to minimize V(D, G) by making D(G(z)) approach 1 (which minimizes the log portion of the function). This creates a zero-sum kind of game where one's gain is the other's loss, which drives continuous improvement.

Q2: What is mode collapse, Why can mode collapse occur during GAN training? and how can it be mitigated?

Mode collapse is when the generator learns to produce only a subset of possible outputs and fails to capture the full diversity of the training data distribution. This can occur during GAN training if the generator exploits weakness in the discriminator rather than learning the full data distribution and on the other hand can happen if the discriminator becomes too strong and provides uninformative gradients to the generator. In addition, if the adversarial nature between the generator and the discriminator is oscillatory then it can prevent convergence. To mitigate mode collapse techniques such as batch normalization, minibatch discrimination, and WGAN can be used.

Q3: Explain the role of the discriminator in adversarial training?

Primarily, the discriminator is a binary classifier that evaluates generated data and distinguishes between real and fake data. It also provides gradients to train the generator through backpropagation and acts as a loss function that adapts during training.

Q4: How do metrics like IS and FID evaluate GAN performance?

IS measures quality and diversity (generated images should have low entropy and marginal distribution should have high entropy). FID measures distributional similarity by comparing feature distributions (not individual samples) and captures intra-class diversity.